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New Fe II energy levels from stellar spectra

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ABSTRACT

Aims. The spectra of B-type and early A-type stars show numerous unidentified lines in the whole optical range, especially in the 5100-5400 Å interval. Because Fe II transitions to high energy levels should be observed in this region, we used semiempirical predicted wavelengths and gf-values of Fe II to identify unknown lines.
Methods. Semiempirical line data for Fe II computed by Kurucz are used to synthesize the spectrum of the slow-rotating, Fe-overabundant CP star HR 6000.
Results. We determined a total of 109 new 4f levels for Fe II with energies ranging from 122 324 cm^{-1} to 128 110 cm^{-1}. They belong to the Fe II subconfigurations $3d^6(^3P)4f$ (10 levels), $3d^6(^3H)4f$ (36 levels), $3d^6(^3F)4f$ (37 levels), and $3d^6(^3G)4f$ (26 levels). We also found 14 even levels from 4d (3 levels), 5d (7 levels), and 6d (4 levels) configurations. The new levels have allowed us to identify more than the 50 % of previously unidentified lines of HR 6000 in the wavelength region 3800-8000 Å. Tables listing the new energy levels are given in the paper; tables listing the spectral lines with $\log gf \geq -1.5$ that are transitions to the 4f energy levels are given in the Online Material. These new levels produce 18000 lines throughout the spectrum from the ultraviolet to the infrared.

Key words. line:identification-atomic data-stars:atmospheres-stars:chemically peculiar- stars:individual:HR 6000

1. Introduction

In a previous paper (Castelli, Kurucz & Hubrig, 2009) (Paper I) we have determined 21 new $3d^6(^3H)4f$ high energy levels of Fe II on the basis of predicted energy levels, computed $\log gf$ values for Fe II, and unidentified lines in UVES high resolution, high signal-to-noise spectra of HR 6000 and 46 Aql. Both stars are iron overabundant CP stars and have rotational velocity v*sini* of the order of 1.5 km s^{-1} and 1.0 km s^{-1}, respectively.

In this paper we continue the effort to determine new high-energy levels of Fe II. We used the same spectra and models for HR 6000 that we adopted in Paper I, together with Fe II line lists which include transitions between observed-observed, observed-predicted, and predicted-predicted energy levels. In this paper we increase the number of the new energy levels from the 21 listed in Paper I, to a total of 109 energy levels, which belong to the Fe II subconfigutations: $3d^6(^3P)4f$ (10 levels), $3d^6(^3H)4f$ (36 levels), $3d^6(^3F)4f$ (37 levels), and $3d^6(^3G)4f$ (26 levels), and 14 levels from the even configurations 4d (3 levels), 5d (7 levels), and 6d (4 levels). The new levels have allowed us to identify more than the 50 % of the previously unidentified lines in the wavelength region 3800-8000 Å of HR 6000 (Castelli & Hubrig, 2007). The method that we adopted to determine the new energy levels is the same as described in Paper I. It is recalled here in Sect. 3. The comparison of the observed spectrum of HR 6000 with the synthetic spectrum which includes the new Fe II lines is available on the Castelli web site[1].

2. The star HR 6000

According to Paper I, the CP star HR 6000 (HD 144667) has an estimated rotational velocity of 1.5 km sec^{-1}. The model stellar parameters for an individual abundance ATLAS12 (Kurucz 2005) model are $T_{\rm eff}$=13450 K, log g=4.3. In addition to the large iron overabundance [+0.9], overabundances of Xe ([+4.6]), P (>[+1.5]), Ti ([+0.55]), Cr ([+0.2]), Mn ([+1.5]), Y ([+1.2]), and Hg ([+2.7]) were observed. This peculiar chemical composition, together with the underabundances of He, C, N, O, Al, Mg, Si, S, Cl, Sc, V, Co, Ni, and Sr gives rise to an optical line spectrum very rich in Fe II lines, with transitions involving upper energy levels close to the ionization limit (Johansson 2009). Also numerous Fe I and Fe III lines are observable in the spectrum.

3. The method

To determine the new energy levels we used high-resolution UVES spectra of HR 6000 (see Paper I), the corresponding synthetic spectrum, and the list of the computed transitions with predicted values for levels with no experimentally available energies. Predicted energy levels and $\log gf$ values were computed by Kurucz with his version of the Cowan (1981) code (Kurucz 2009). The calculation included 46 even configurations d^7, $d^6 4s-9s$, $d^6 4d-9d$, $d^6 5g-9g$, $d^6 7i$-$9i$, $d^6 9l$, $d^5 4s^2$, $d^5 4s5s-9s$, $d^5 4s4d-9d$, $d^5 4s5g$-$9g$, $d^5 4s7i-9i$, $d^5 4s9l$, $d^4 4s^2 4d$, and $d^5 4p^2$ with 19771 levels least-squares fitted to 418 known levels. The 39 odd configurations included $d^6 4p-9p$, $d^6 4f-9f$, $d^6 6h-9h$, $d^6 8k-9k$, $d^5 4s4p-9p$, $d^5 4s4f-9f$, $d^5 4s6h-9h$, $d^5 4s8k$-$9k$, $d^4 4s^2 4p-5p$, and $d^4 4s^2 4f$ with 19652 levels least-squares fitted to 596 known levels. The calculations were done in LS coupling with all configuration interactions included, with scaled Hartree-Fock starting guesses, and with Hartree-Fock transition integrals. A total of 7080169 lines were saved from the transition array of which 102833 lines are between known levels and have good wavelengths. The computed line list was sorted into tables of all the strong lines connected to every predicted level.

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[1] http://wwwuser.oat.ts.astro.it/castelli/hr6000new/hr6000.html

When a given predicted level gives rise to at least two Fe II lines having log $gf \geq -1.0$, we selected one of these transitions and searched in the spectrum for those unidentified lines which have wavelength within ±50 Å and residual flux within about ± 5% of those of the selected predicted line. From the observed wavelength of one of these unidentified lines and from the known energy of the lower or upper level of the predicted transition, we derived a possible energy for the predicted level. If most of transitions obtained with this energy correspond to lines observed in the spectrum, we kept the tentative energy value as a real value, otherwise we repeated the procedure using another line taken from the unidentified ones, and continued the searching until we found that energy for which most of the predicted lines correspond to the observed lines. Whenever one or more new levels were found, the whole semiempirical calculation was repeated to produce improved predicted wavelengths and log gf-values. Because all configuration interactions were included, and because the mixing is exceptionally strong in the 4d and 5d configurations, every new level changed the predictions. Mixing between close levels can produce large uncertainties in the log gf values for lines that involve those levels.

This procedure is very successfull for levels which produce two or more transitions with log $gf > 0.0$, but becomes more and more difficult as the intensity of the predicted lines decreases. In fact, weak lines are usually blended with stronger components, so that the method may fail in these cases.

4. The new energy levels

The new energy levels of the $3d^6(^3P)4f$, $3d^6(^3H)4f$, $3d^6(^3F)4f$, and $3d^6(^3G)4f$ subconfigurations and from the even configurations $3d^64d$, $3d^65d$, and $3d^66d$ are listed in Tables 1−5. Because the $3d^64f$ states of Fe II tend to appear in pairs we have used the $j_c[K]_j$ notation of jK coupling for them, where $\mathbf{j}_c$ is the total angular momentum of the core and $\mathbf{K}=\mathbf{J}_c+\mathbf{l}$ is the coupling of $\mathbf{J}_c$ with the orbital angular momentum $\mathbf{l}$ of the active electron. The level pairs correspond to the two separate values of the total angular momentum $\mathbf{J}$ obtained when the spin s=±1/2 of the active electron is added to $\mathbf{K}$. The positive energies are those obtained by comparing observed and predicted line profiles, as described in Sect. 3 and shown in Fig. 2. The energies between parentheses in Tables 1−4 are predicted values for which we have been not able to find the corresponding observed level. The reason for the failure is that either all the lines from the energy level are weak or, even if some of the transitions are predicted as moderately strong (log $gf > 0.0$), they are blended with other stronger components, so that their identification is uncertain. The columns with label "c−o" in Tables 1-5 show the difference between the predicted and observed energy levels.

The 4d even energy levels listed in Table 5 give rise to some of the transitions listed in the Online Material. The strongest transitions related with the 5d, and 6d even energy levels occur in the 6000-8000 Å region and in the 4000-5000 Å region, respectively. The transitions to the odd energy levels are discussed in Sect. 5

The observed energy levels, the least squares fits, the predicted energy levels, and the line lists can be found on the Kurucz web site[2]. The observed levels come from the following sources: Johansson (1978), Sugar & Corliss (1985), Adam et al. (1987), Johansson & Baschek (1988), Johansson (1988, private communication), Rosberg & Johansson (1992), Castelli, Johansson & Hubrig (2008), Castelli, Kurucz, Hubrig (2009), and this work.

[2] http://kurucz.harvard.edu/atoms/2601

Table 5. Fe II new levels from $3d^64d$, $3d^65d$, and $3d^66d$ configurations.

Designation		J	Energy cm^{-1}	c−o cm^{-1}
$3d^6(^3P)4d$	^2F	7/2	103191.917	+27.014
$3d^6(^3P)4d$	^2D	5/2	103597.402	−5.701
$3d^6(^3F)4d$	^2F	7/2	105775.491	−42.697
$3d^6(^3H)5d$	^4H	13/2	124208.725	+47.495
$3d^6(^3H)5d$	^4G	11/2	124251.805	+44.041
$3d^6(^3H)5d$	^4K	15/2	124297.017	−5.220
$3d^6(^3H)5d$	^4I	15/2	124357.304	+12.292
$3d^6(^3H)5d$	^4K	13/2	124415.353	−14.256
$3d^6(^3H)5d$	^2I	11/2	124976.008	−38.096
$3d^6(^3F)5d$	^4H	13/2	125732.991	+9.243
$3d^6(^5D)6d$	^6D	5/2	113934.466	−58.836
$3d^6(^5D)6d$	^4D	7/2	114009.934	−3.477
$3d^6(^5D)6d$	^6G	7/2	114428.399	+51.787
$3d^6(^5D)6d$	^6G	5/2	114619.007	+22.415

The calculations on the web site are updated whenever there are improvements to the energy levels.

5. The new Fe II lines

The new Fe II lines in the 3800-8000 Å region, produced by transitions to the Fe II subconfigurations (^3P)4f, (^3H)4f, (^3F)4f, and (^3G)4f, are shown in Tables 6−9, respectively. Only lines with log $gf \geq -1.50$ are listed, because lines with lower log gf values are not observable in this wavelength region of HR 6000. The new Fe II lines are mostly concentrated in the 5100-5400 Å interval. The upper energy levels (cols. 1−4) were derived as described in Sect. 3, the lower energy levels (cols. 5−6) are those described in Sect. 4, the calculated wavelength (col. 7) is the Ritz wavelength in air, the log gf values (col. 8) were computed by Kurucz, the observed wavelengths (col. 9) are the wavelengths of lines well observable in the HR 6000 spectrum. Most of them were listed as unidentified lines in Castelli & Hubrig (2007)[3]. In the last column, comments derived from the comparison of the observed and computed spectra are added for most lines. In a few cases, both computed and observed stellar lines correspond to lines measured by Johansson in laboratory works (Johansson 1978; Castelli, Johansson, & Hubrig 2008). The notes "J78" and "lab" are added for these lines. When lines are computed weaker than the observed ones the disagreement can be due either to a too low log gf value or to some unknown component which increases the line intensity. When lines are computed much stronger than the observed ones, some problem with the energy levels or/and log gf computations is very probably present. When we observed a very good agreement between the observed and computed lines, either isolated or blends, we added the note "good agreement".

Figure 1 shows the Fe II spectrum in the 5185-5196 Å interval, computed before and after the determination of the new energy levels. Figure 2 compares the observed spectrum of HR 6000 with the synthetic spectrum computed with the line list including the new Fe II lines. When the two figures are considered together, the improvement in the comparison between the observed and computed spectra is evident.

[3] http://wwwuser.oat.ts.astro.it/castelli/hr6000/unidentified.txt

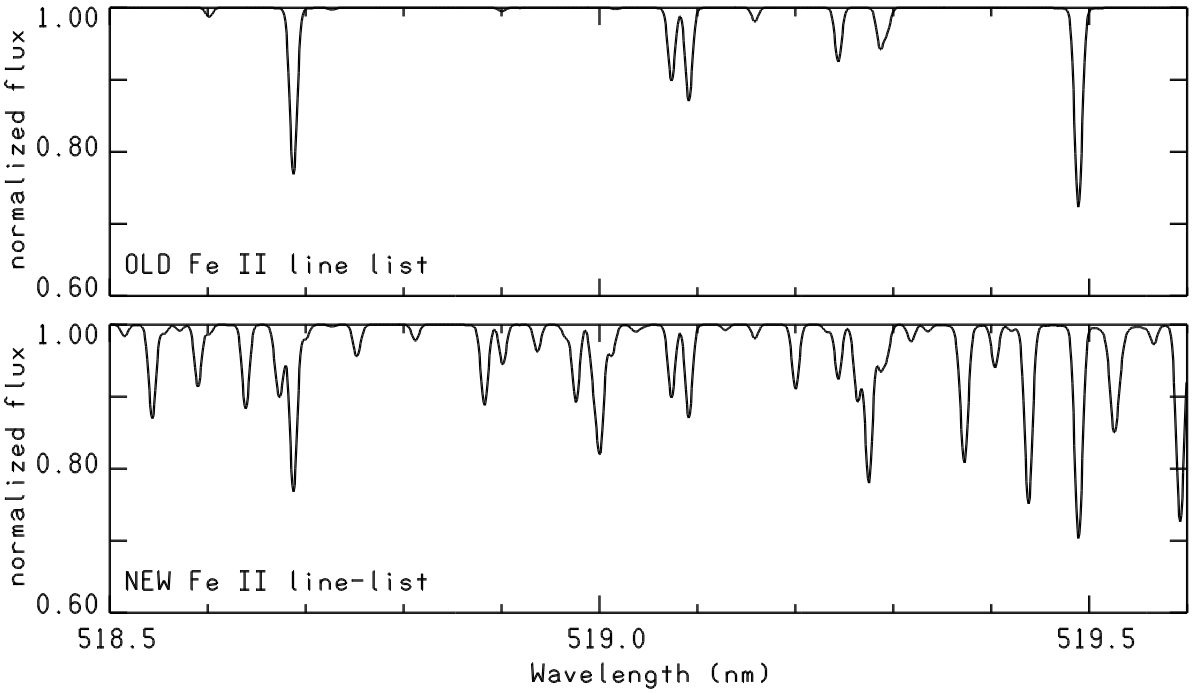

Fig. 1. Upper panel shows the Fe II synthetic spectrum for the parameters of HR 6000 ($T_{\rm eff}$=13450 K, log g=4.3, v$sini$=1.5 km^{-1}, [Fe/H]]=+0.9) computed with the line list availble before this work. The lower panel is the same, but with the new Fe II lines added in the line list.

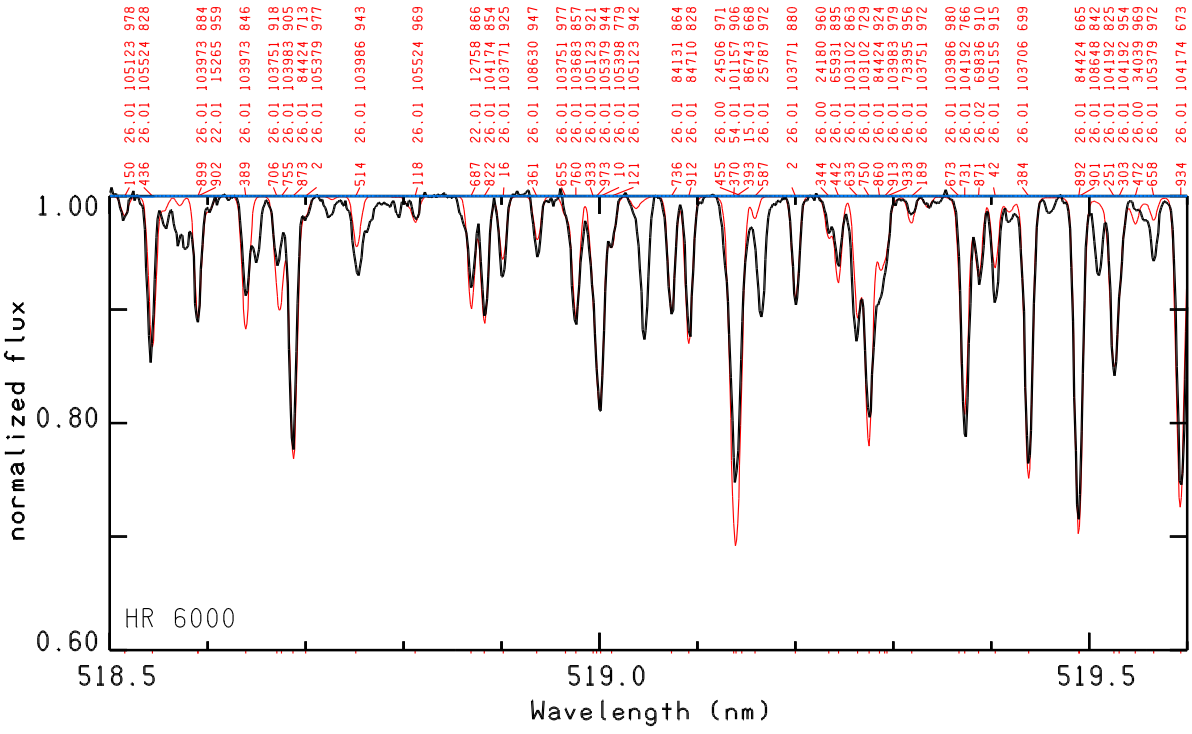

Fig. 2. Comparison of the UVES spectrum of HR 6000 (black line) with a synthetic spectrum (red line) computed with a line list including the new Fe II lines. The line identification can be decoded as follows: for the first line, 150 last 3 digits of wavelength 518.5150 nm; 26 atomic number of iron; .01 charge/100, i.e. 26.01 identifies the line as Fe II; 105123 is the energy of the lower level in cm^{-1}; 970 is the residual central intensity in per mil.

Table 1. Fe II energy levels for the $3d^6$ (^{3}P)4f subconfiguration. Energies between parentheses are predicted values.

Design-ation	J	Energy cm^{-1}	c−o cm^{-1}	Design-ation	J	Energy cm^{-1}	c−o cm^{-1}	Design-ation	J	Energy cm^{-1}	c−o cm^{-1}
2[5]	11/2	122351.810	−20.236								
	9/2	122324.142	−18.980								
2[4]	9/2	122355.116	−6.685	1[4]	9/2	123629.520	−4.606				
	7/2	122355.553	−6.801		7/2	123637.833	−6.417				
2[3]	7/2	122351.488	−18.489	1[3]	7/2	123615.875	−2.642	0[3]	7/2	(124167.229)	
	5/2	(122353.541)			5/2	123649.493	−5.687		5/2	124157.060	+15.841
2[2]	5/2	(122342.921)		1[2]	5/2	(123637.063)					
	3/2	(122336.098)			3/2	(123646.360)					
2[1]	3/2	(122358.405)									
	1/2	(122332.608)									

Table 2. Fe II energy levels for the $3d^6$ (^{3}H)4f subconfiguration. Energies between parentheses are predicted values.

Design-ation	J	Energy cm^{-1}	c−o cm^{-1}	Design-ation	J	Energy cm^{-1}	c−o cm^{-1}	Design-ation	J	Energy cm^{-1}	c−o cm^{-1}
6[9]	19/2	122954.180	+14.465								
	17/2	122952.730	+20.251								
6[8]	17/2	123007.910	+26.752	5[8]	17/2	123219.200	−10.198				
	15/2	122910.920	−16.531		15/2	123193.090	−17.864				
6[7]	15/2	123018.430	+34.439	5[7]	15/2	123238.440	−6.653	4[7]	15/2	123396.250	−33.027
	13/2	123015.400	+40.333		13/2	123168.680	−33.645		13/2	123355.490	−36.436
6[6]	13/2	122990.620	−2.720	5[6]	13/2	123249.650	−6.519	4[6]	13/2	123414.730	−32.244
	11/2	123037.430	+26.878		11/2	123270.340	+0.899		11/2	123427.119	−33.418
6[5]	11/2	123002.288	+33.455	5[5]	11/2	123251.470	−1.320	4[5]	11/2	123441.100	−26.889
	9/2	123026.350	+18.587		9/2	123269.378	+2.937		9/2	123435.468	−17.705
6[4]	9/2	122988.215	+30.836	5[4]	9/2	123258.994	−1.556	4[4]	9/2	123460.690	−26.898
	7/2	122980.408	+26.752		7/2	123258.021	−1.362		7/2	123435.277	−16.103
6[3]	7/2	122946.419	+21.403	5[3]	7/2	123235.165	+3.471	4[3]	7/2	123451.449	−21.115
	5/2	(122967.896)			5/2	(123248.017)			5/2	123430.181	−16.906
				5[2]	5/2	123211.159	−1.017	4[2]	5/2	(123401.927)	
					3/2	123213.323	−12.585		3/2	(123384.857)	
								4[1]	3/2	(123356.410)	
									1/2	(123343.705)	

6. Conclusions

Computed atomic data and stellar spectra observed at high resolution and high signal-to-noise ratio of the iron−overabundant, slow−rotating star HR 6000 were used to extend laboratory studies on Fe II energy levels and line transitions. We identified as Fe II about 500 unidentified spectral lines in the 3800−8000 Å region. A few of these lines were already identified as iron from laboratory analyses (Johansson 2007, private communication), but they were never classified. Because numerous other new lines are components of blends they contribute to improve the agreement between observed and computed spectra. On the other hand, there is a small number of new lines which are not observed in the spectrum. We believe that they are due to computational problems related with the mixing of the even energy levels rather than to incorrect energy values for the new 4f odd levels.

In spite of the large number of the new identified lines, several medium-strong lines and a conspicuous number of weak lines remain still unidentified in the spectral region we analyzed. If we examine the list of the Fe II lines which correspond to transitions from predicted energy levels, we can count about 4600 lines with $\log gf \geq -1.0$, where about 400 of them have $\log gf \geq 0.0$. Because the transitions producing these lines occur between high-excitation energy levels that are not strongly populated, most of the lines are weak in a star like HR 6000. This

Table 3. Fe II energy levels for the $3d^6$ (^{3}F)4f subconfiguration. Energies between parentheses are predicted values.

Design-ation	J	Energy cm^{-1}	c−o cm^{-1}	Design-ation	J	Energy cm^{-1}	c−o cm^{-1}	Design-ation	J	Energy cm^{-1}	c−o cm^{-1}
4[7]	15/2	124421.468	+12.238								
	13/2	124436.436	+36.895								
4[6]	13/2	124400.107	+4.567	3[6]	13/2	124661.274	+15.827				
	11/2	124402.557	−3.593		11/2	124656.535	+7.092				
4[5]	11/2	124388.840	+3.174	3[5]	11/2	124626.900	+3.179	2[5]	11/2	124803.873	+20.054
	9/2	124385.706	+2.938		9/2	124636.116	+3.120		9/2	124809.727	+15.721
4[4]	9/2	124401.939	+4.674	3[4]	9/2	124623.120	+3.085	2[4]	9/2	124793.905	+12.624
	7/2	124385.010	+0.698		7/2	124620.914	+7.289		7/2	124783.748	+15.272
4[3]	7/2	124416.110	+13.187	3[3]	7/2	124641.989	+9.092	2[3]	7/2	(124814.025)	
	5/2	124403.474	+1.243		5/2	124653.022	−8.651		5/2	(124808.178)	
4[2]	5/2	124434.563	+23.142	3[2]	5/2	(124670.316)		2[2]	5/2	(124835.676)	
	3/2	124460.410	−11.802		3/2	(124678.325)			3/2	(124833.418)	
4[1]	3/2	(124487.989)		3[1]	3/2	(124697.077)		2[1]	3/2	(124876.972)	
	1/2	(124484.721)			1/2	(124708.453)			1/2	(124874.375)	
				3[0]	1/2	124731.762	−4.875				

Table 4. Fe II energy levels for the $3d^6$ (^{3}G)4f subconfiguration. Energies between parentheses are predicted values.

Design-ation	J	Energy cm^{-1}	c−o cm^{-1}	Design-ation	J	Energy cm^{-1}	c−o cm^{-1}	Design-ation	J	Energy cm^{-1}	c−o cm^{-1}
5[8]	17/2	127507.241	−5.657								
	15/2	127524.1227	+14.501								
5[7]	15/2	127484.653	−1.445	4[7]	15/2	127892.981	+4.313				
	13/2	127515.235	+2.816		13/2	127895.260	+3.367				
5[6]	13/2	127489.429	−4.823	4[6]	13/2	127875.000	+2.236	3[6]	13/2	128110.214	−2.182
	11/2	127489.977	−0.294		11/2	127880.436	+1.216		11/2	(128076.012)	
5[5]	11/2	127482.748	+3.147	4[5]	11/2	127869.158	+0.993	3[5]	11/2	128071.171	−10.517
	9/2	(127484.561)			9/2	127855.952	−16.898		9/2	128055.658	−16.898
5[4]	9/2	127485.362	−15.194	4[4]	9/2	127869.892	−4.920	3[4]	9/2	128062.710	−15.669
	7/2	127485.699	+9.404		7/2	(127871.098)			7/2	128066.823	−22.228
5[3]	7/2	(127476.624)		4[3]	7/2	(127877.776)		3[3]	7/2	(128047.849)	
	5/2	127510.913	+9.552		5/2	127874.745	+5.549		5/2	128063.103	−8.192
5[2]	5/2	(127499.343)		4[2]	5/2	(127868.807)		3[2]	5/2	128089.313	+10.032
	3/2	127487.681	−0.341		3/2	(127895.930)			3/2	(128069.044)	
				4[1]	3/2	(127876.787)		3[1]	3/2	(128099.051)	
					1/2	(127898.510)			1/2	(128099.237)	
								3[0]	1/2	(128161.312)	

large number of weak predicted lines could explain the spectrum of HR 6000 longward of about 5800 Å. The spectrum looks like it is affected by a noise larger than that due to the instrumental effects. Castelli & Hubrig (2007) explained this "noise" with the presence of a T-Tauri star affecting the HR 6000 spectrum. After this study, we prefer to state that the spectrum shows the presence of numerous weak Fe II lines from high-excitation levels, probably 4d, 5d, 6d – 4f, 5f, 6f transitions, which still have to be identified. The hypothesis of the presence of the T-Tauri star affecting the HR 6000 spectrum is an example of an incorrect

conclusion that can be drawn owing to the use of incomplete line lists. We will extend this study of the Fe II spectrum to the near infrared region in the near future using CRIRES (CRyogenic high-resolution InfraRed Echelle Spectrograph) observations of HR 6000 and 46 Aql. The observations are scheduled in summer 2010 (ESO proposal 41380, P. I. S. Hubrig).

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Table 6. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3P)4f$ energy levels as upper levels

Upper level				Lower level		λ(calc)	$log\,gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
122351.810	$(^3P)4f$	2[5]	11/2	103165.320	$(^3P)4d\ ^4F_{9/2}$	5210.550	+0.795	5210.55	good agreement
				103683.070	$(^5D)5d\ ^4F_{9/2}$	5355.059	+0.164	5355.06	computed too strong
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5380.493	−1.047		at the noise level
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5698.178	−0.539		blend with a telluric line
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5733.913	−0.635	5733.90	computed too weak
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6396.332	−0.741	6396.32	computed too weak
				109811.920	$(^3G)4d\ ^4F_{9/2}$	7972.359	−0.985		at the noise level
122324.142	$(^3P)4f$	2[5]	9/2	103102.860	$(^3P)4d\ ^4D_{7/2}$	5201.118	−0.056		wrong,not observed
				103191.917	$(^3P)4d\ ^2F_{7/2}$	5225.329	+0.634		blend, good agreement
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5451.698	−1.133		blend, good agreement
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5488.097	−0.362		blend, good agreement
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5603.024	−0.170	5603.05	
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5811.956	−1.441		blend,good agreement
				105775.491	$(^3F)4d\ ^2F_{7/2}$	6041.116	−0.837	6041.1	weak,good agreement
122355.116	$(^3P)4f$	2[4]	9/2	102394.718	$(^5D)6s\ ^4D_{7/2}$	5008.523	−0.809		weak, computed too strong
				103102.860	$(^3P)4d\ ^4D_{7/2}$	5192.750	+0.657	5192.75	lab, good agreement
				103165.320	$(^3P)4d\ ^4F_{9/2}$	5209.652	−0.035	5209.66	lab, good agreement
				103191.917	$(^3P)4d\ ^2F_{7/2}$	5216.883	−0.404		blend
				103683.070	$(^5D)5d\ ^4F_{9/2}$	5354.110	−0.637	5354.1	weak
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5478.781	−1.319		at the continuum level
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5697.105	−1.443		at the continuum level
				106767.210	$(^3F)4d\ ^4F_{7/2}$	6413.457	−1.407		blend
122355.550	$(^3P)4f$	2[4]	7/2	102394.718	$(^5D)6s\ ^4D_{7/2}$	5008.414	−1.258		good agreement
				102802.312	$(^5D)6s\ ^4D_{5/2}$	5112.818	−0.959	5112.82	computed too weak
				103002.670	$(^3P)4d\ ^4D_{5/2}$	5165.751	+0.441	5165.75	lab, good agreement
				103102.860	$(^3P)4d\ ^4D_{7/2}$	5192.633	+0.155	5192.62	lab, computed too weak
				103165.320	$(^3P)4d\ ^4F_{9/2}$	5209.534	−1.105		blend, good agreement
				103191.917	$(^3P)4d\ ^2F_{7/2}$	5216.765	−0.764		blend
				106796.660	$(^3F)4d\ ^4P_{5/2}$	6425.418	−1.436		at the continuum level
122351.488	$(^3P)4f$	2[3]	7/2	103102.860	$(^3P)4d\ ^4D_{7/2}$	5193.729	−1.320		blend
				103191.917	$(^3P)4d\ ^2F_{7/2}$	5217.871	−0.250	5217.870	lab
				103597.402	$(^3P)4d\ ^2D_{5/2}$	5330.689	+0.525	5330.680	lab
				104023.910	$(^3H)4d\ ^4G_{5/2}$	5454.742	−1.327		at the continuum level
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5479.870	−1.320		at the continuum level
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5594.450	−1.116	5594.42	computed too weak ?
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5622.022	−0.573	5622.02	computed too weak ?
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5840.440	−1.282		at the continuum level
				107407.800	$(^3F)4d\ ^2D_{5/2}$	6689.941	−0.330	6689.91	
123629.520	$(^3P)4f$	1[4]	9/2	103102.860	$(^3P)4d\ ^4D_{7/2}$	4870.353	−1.402		at the continuum level
				104000.810	$(^5D)5d\ ^6P_{7/2}$	5093.159	−0.981		blend
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5121.112	+0.327	5121.1	lab, good agreement
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5221.043	+0.408	5221.04	lab, good agreement
				104873.230	$(^5D)5d\ ^4D_{7/2}$	5330.062	−1.183		blend
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5364.564	−0.118	5364.55	computed too strong
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5401.999	−0.418		blend
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5430.640	−1.066	5430.64	computed too weak
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5599.422	−0.624	5599.42	good agreement
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5928.743	−0.677	5928.72	at the noise level
				110167.280	$(^3G)4d\ ^4F_{7/2}$	7426.139	−1.173		

Table 6. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3P)4f$ energy levels as upper levels

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
123637.833	$(^3P)4f$	1[4]	7/2	102802.312	$(^5D)6s\ ^4D_{5/2}$	4798.155	−1.297		at the continuum level
				103002.670	$(^3P)4d\ ^4D_{5/2}$	4844.743	−0.954		computed too strong
				103597.402	$(^3P)4d\ ^2D_{5/2}$	4988.521	−0.339	4988.51	lab
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5118.932	−0.819	5118.95	lab, computed too weak
				104120.270	$(^5D)5d\ ^6P_{5/2}$	5122.163	−1.282		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5218.777	−0.644		blend
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5242.763	+0.180	5242.775	lab
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5362.172	−1.268		at the continuum level
				105127.770	$(^5D)5d\ ^4D_{5/2}$	5400.965	−1.143		at the continuum level
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5432.211	−0.531		wrong, not observed
				105379.430	$(^3F)4d\ ^4D_{5/2}$	5475.409	−0.552	5475.42	computed too strong
				105711.730	$(^5D)5d\ ^6S_{5/2}$	5576.909	−1.432		at the continuum level
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5735.883	−1.221		at the continuum level
				106796.660	$(^3F)4d\ ^4P_{5/2}$	5936.184	−1.317		at the level of the noise
				106866.760	$(^3F)4d\ ^4F_{5/2}$	5960.996	−0.565	5961.00	
				107407.800	$(^3F)4d\ ^2D_{5/2}$	6159.712	−0.665	6179.75	blend ?
				110428.280	$(^3G)4d\ ^4F_{5/2}$	7568.195	−1.229		no spectrum
123615.875	$(^3P)4f$	1[3]	7/2	103597.402	$(^3P)4d\ ^2D_{5/2}$	4993.993	−1.435		
				104023.910	$(^3H)4d\ ^4G_{5/2}$	5102.711	−0.526	5102.7	lab, good agreement
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5124.694	−1.046	5124.69	good agreement
				104120.270	$(^5D)5d\ ^6P_{5/2}$	5127.932	−0.244		wrong, not obs
				104209.610	$(^3H)4d\ ^2F_{5/2}$	5151.540	−0.081	5151.52	J78, lab, computed too weak
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5224.766	−0.973	5227.77	good agreement
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5248.807	−0.232	5248.801	computed too strong
				105127.770	$(^5D)5d\ ^4D_{5/2}$	5407.380	−1.391	5407.37	computed too weak
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5438.700	−0.416	5438.70	computed too strong
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5743.118	−0.454	5743.10	good agreement
123649.493	$(^3P)4f$	1[3]	5/2	104209.610	$(^3H)4d\ ^2F_{5/2}$	5142.631	−1.288		at the continuum level
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5239.559	−1.150	5239.56	good agreement
				104572.920	$(^3P)4d\ ^4F_{3/2}$	5240.573	+0.071	5240.587	lab, good agreement
				104588.710	$(^5D)5d\ ^6D_{3/2}$	5244.914	−1.288		blend
				104839.998	$(^3P)4d\ ^2D_{3/2}$	5314.985	−0.441		blend,computed too strong
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5428.771	−1.471		blend
				105317.440	$(^3P)4d\ ^2P_{3/2}$	5453.411	+0.082	5453.42	lab, computed too strong
				105518.140	$(^3H)4d\ ^4F_{3/2}$	5513.777	−0.591		wrong, not observed
				106846.650	$(^3F)4d\ ^4F_{3/2}$	5949.725	−1.358		at the continuum level
				107430.250	$(^3F)4d\ ^2D_{3/2}$	6163.810	−0.253		wrong, not observed
				108105.900	$(^3F)4d\ ^2P_{3/2}$	6431.741	−0.724		blend
124157.060	$(^3P)4f$	0[3]	5/2	104569.230	$(^3P)4d\ ^4F_{5/2}$	5103.788	−1.191	5103.8	good agreement
				104572.920	$(^3P)4d\ ^4F_{3/2}$	5104.750	+0.094	5104.75	lab, good agreement
				104588.710	$(^5D)5d\ ^6D_{3/2}$	5108.869	−1.369		
				104839.998	$(^3P)4d\ ^2D_{3/2}$	5175.329	−1.125		blend
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5283.154	−0.937		blend
				105317.440	$(^3P)4d\ ^2P_{3/2}$	5306.486	−1.020	5306.49	computed too weak
				105460.230	$(^3F)4d\ ^4D_{3/2}$	5347.013	−0.482	5347.05	blend
				105518.140	$(^3H)4d\ ^4F_{3/2}$	5363.626	+0.082	5363.61	computed too strong
				106846.650	$(^3F)4d\ ^4F_{3/2}$	5775.269	−0.286	5775.25	good agreement
				107430.250	$(^3F)4d\ ^2D_{3/2}$	5976.771	−0.922		blend
				108105.900	$(^3F)4d\ ^2P_{3/2}$	6228.356	−0.686	6228.34	good agreement
				110609.540	$(^3G)4d\ ^4F_{3/2}$	7379.392	−1.370		at the continuum level

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy level as upper levels

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
122954.180	$(^3H)4f$	6[9]	19/2	103644.800	$(^3H)4d\ ^4K_{17/2}$	5177.388	+1.169	5177.394	J78, lab, good agreement
122952.730	$(^3H)4f$	6[9]	17/2	103644.800	$(^3H)4d\ ^4K_{17/2}$	5177.777	−0.930		blend
				103706.530	$(^3H)4d\ ^4K_{15/2}$	5194.384	+0.798	5194.387	lab, good agreement
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5241.181	+0.558	5241.183	J78, lab, good agreement
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5308.346	+0.518	5308.350	J78,lab, good agreement
123007.910	$(^3H)4f$	6[8]	17/2	103644.800	$(^3H)4d\ ^4K_{17/2}$	5163.021	+0.498	5163.018	J78,lab, good agreement
				103706.530	$(^3H)4d\ ^4K_{15/2}$	5179.534	+0.534	5179.540	J78, lab, good agreement
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5226.062	+0.820	5226.070	lab, good agreement
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5292.838	−1.419		
				108337.860	$(^3G)4d\ ^4I_{15/2}$	6814.729	−1.183		at the noise level
122910.920	$(^3H)4f$	6[8]	15/2	103706.530	$(^3H)4d\ ^4K_{15/2}$	5205.693	−0.207	5205.70	blend
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5239.942	+0.015	5239.948	J78, lab, computed too weak
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5252.695	−0.107	5252.702	lab, computed too weak
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5304.620	−0.357	5304.60	lab, computed too weak
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5320.157	+0.082	5320.18	lab, good agreement
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5376.136	+0.132	5376.12	lab, computed too weak
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5466.362	+0.698	5466.38	good agreement
				108463.910	$(^3G)4d\ ^4I_{13/2}$	6919.939	−0.887		at the continuum level
				108648.695	$(^1I)5s\ e^2I_{13/2}$	7009.596	−1.436	7009.6 ?	computed too weak ?
				109049.600	$(^3G)4d\ ^2I_{13/2}$	7212.332	−1.456	7212.33 ?	computed too weak ?
123018.430	$(^3H)4f$	6[7]	15/2	103617.580	$(^3H)4d\ ^4H_{13/2}$	5152.978	+0.761	5152.985	lab, good agreement
				103644.800	$(^3H)4d\ ^4K_{17/2}$	5160.218	−0.354	5160.213	lab, good agreement
				103706.530	$(^3H)4d\ ^4K_{15/2}$	5176.713	+0.364	5176.722	J78,lab, good agreement
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5210.580	−1.104	5210.65 ?	computed too weak ?
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5223.190	+0.447	5223.25	blend, good agreement
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5274.530	−1.138	5274.53	good agreement
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5289.892	−0.894	5289.899	lab, good agreement
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5434.415	−1.378		at the noise level
				108337.860	$(^3G)4d\ ^4I_{15/2}$	6809.845	−1.228		at the noise level
123015.400	$(^3H)4f$	6[7]	13/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	5149.230	+0.424	5149.243	lab, good agreement
				103617.580	$(^3H)4d\ ^4H_{13/2}$	5153.783	+0.761	5153.786	lab, good agreement
				103706.530	$(^3H)4d\ ^4K_{15/2}$	5177.525	−0.341		blend
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5189.655	−0.783		blend, good agreement
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5224.017	−0.132	5224.025	lab, good agreement
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5290.740	−1.258	5290.730	computed too weak
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5477.945	−1.275	5477.95	good agreement
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5568.910	−1.164	5568.92	good agreement
				105288.850	$(^3F)4d\ ^4H_{13/2}$	5639.690	−1.357		blend
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5891.220	−1.302		blend
				108181.550	$(^3G)4d\ ^4G_{11/2}$	6739.478	−1.459		at the noise level
122990.620	$(^3H)4f$	6[6]	13/2	103706.530	$(^3H)4d\ ^4K_{15/2}$	5184.178	−0.976		blend
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5196.339	−0.126	5196.32	computed too weak
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5218.143	−0.028	5218.149	lab, good agreement
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5230.790	−1.208	5230.80	good agreement
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5257.034	−0.940		blend
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5282.281	−1.039	5282.29	blend,computed too weak
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5297.687	−1.010	5297.7	blend
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5313.049	−0.954		blend
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5353.192	+0.205	5353.22	blend, computed too strong
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5442.643	+0.049	5442.65	J78, lab, good agreement
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5485.393	+0.141	5485.40	computed too strong

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy level as upper levels

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
122990.620	cont.			105063.550	$(^3F)4d\ ^4G_{11/2}$	5576.608	−0.487	5576.60	computed too strong
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5803.114	−0.380	5803.12	computed too weak
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5899.835	+0.277	5899.82	good agreement
				108630.429	$(^1I)5s\ e^2I_{11/2}$	6961.775	−1.168		at the continuum level
				109049.600	$(^3G)4d\ ^2I_{13/2}$	7171.100	−1.477		at the continuum level
				109389.880	$(^3G)4d\ ^2I_{11/2}$	7350.516	−1.297	7350.49 ?	computed too weak ?
				109683.280	$(^3G)4d\ ^2H_{11/2}$	7512.581	−0.706		blend, computed too weak ?
123037.430	$(^3H)4f$	6[6]	11/2	103751.660	$(^3H)4d\ ^4H_{11/2}$	5183.727	+0.242	5183.713	J78, lab, blend
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5189.016	−0.187	5189.013	lab
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5205.425	−0.558	5205.427	lab, blend
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5216.891	−0.503		blend
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5269.248	−0.797	5269.235	
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5339.807	−0.759		
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5428.808	−0.405	5428.80	lab
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5471.340	−0.934		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5483.874	−0.019	5483.85	lab
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5516.963	−0.234		wrong, not obs
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5562.084	−1.223		
				105398.850	$(^3F)4d\ ^4H_{11/2}$	5667.818	−1.176		
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5787.389	−0.146	5787.35	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5883.582	+0.287	5883.58	J78
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5901.584	−0.581		blend
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6204.452	−1.391		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	7486.247	−0.596		
123002.288	$(^3H)4f$	6[5]	11/2	103165.320	$(^3P)4d\ ^4F_{9/2}$	5039.690	−0.526		
				103600.430	$(^3H)4d\ ^4G_{11/2}$	5152.712	+0.662	5152.70	lab
				103617.580	$(^3H)4d\ ^4H_{13/2}$	5157.271	+0.380		blend
				103683.070	$(^3H)4d\ ^4F_{9/2}$	5174.754	−0.491	5174.75	lab
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5193.192	−0.719	5193.191	blend
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5198.501	−1.338		
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5481.886	−1.256		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5494.468	−0.835		
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5527.686	−1.221	5527.68	computed too weak
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5572.983	−0.697	5572.98	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5895.778	−1.407		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6140.765	−0.940		
				108181.550	$(^3G)4d\ ^4G_{11/2}$	6745.444	−1.310		
				109811.920	$(^3G)4d\ ^4F_{9/2}$	7579.208	−1.201		
123026.350	$^3H)4f$	6[5]	9/2	103102.860	$(^3P)4d\ ^4D_{7/2}$	5017.801	−1.092		
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5186.706	−0.152	5186.722	lab
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5192.002	+0.073	5192.010	lab
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5219.909	−0.488		blend
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5284.389	−0.355		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5390.860	−1.184		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5487.209	+0.186	5487.21	lab
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5520.339	−0.063		wrong, not observed
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5544.006	−1.091		
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5791.103	−0.522	5791.05	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5887.421	−0.109	5887.42	
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5905.446	−0.710		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6131.699	−1.253		
				106767.210	$(^3F)4d\ ^4F_{7/2}$	6148.685	−1.351		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6208.722	−0.916		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	7492.464	−1.002		

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy levels as upper levels

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
122988.215	$(^3H)4f$	6[4]	9/2	103165.320	$(^3P)4d\ ^4F_{9/2}$	5043.266	−0.030		
				103600.430	$(^3H)4d\ ^4G_{11/2}$	5156.450	+0.529	5156.45	lab
				103683.070	$(^3H)4d\ ^4F_{9/2}$	5178.524	−0.018	5178.53	lab
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5196.989	−0.773		
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5202.306	−0.787		
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5486.117	−1.286		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5498.718	−0.382	5498.72	
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5531.988	−1.028		
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5577.356	−0.785	5577.35	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5900.673	−1.342		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6146.075	−0.412	6146.08	
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6223.461	−1.178		
				108181.550	$(^3G)4d\ ^4G_{11/2}$	6751.852	−1.421		
				109811.920	$(^3G)4d\ ^4F_{9/2}$	7587.298	−0.695		
122980.408	$(^3H)4f$	6[4]	7/2	103102.860	$(^3P)4d\ ^4D_{7/2}$	5029.399	−0.735		
				103165.320	$(^3P)4d\ ^4F_{9/2}$	5045.253	−0.962		
				103683.070	$(^3H)4d\ ^4F_{9/2}$	5180.619	−1.116		
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5204.420	−0.034	5204.419	
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5232.461	−0.656		
				103921.630	$(^3H)4d\ ^4G_{7/2}$	5245.466	−1.235		
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5297.253	+0.049	5297.26	
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5404.248	−0.598		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5501.081	−0.147		
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5534.379	−0.071		
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5558.167	−0.731		
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5921.516	−0.986		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6149.026	−0.728		
				106767.210	$(^3F)4d\ ^4F_{7/2}$	6166.108	−1.069		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6226.487	−1.380		
122946.419	$(^3H)4f$	6[3]	7/2	103102.860	$(^3P)4d\ ^4D_{7/2}$	5038.014	−1.413		
				103165.320	$(^3P)4d\ ^4F_{9/2}$	5053.922	+0.160		
				103683.070	$(^3H)4d\ ^4F_{9/2}$	5189.760	+0.167	5189.763	lab.
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5213.645	−0.746		
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5306.811	−0.814		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5511.388	−0.043	5511.40	
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5619.156	−1.229		
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5636.890	−1.411		
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5933.462	−1.332		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6161.908	−0.227	6161.90	
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6239.696	−0.856		
				109811.920	$(^3G)4d\ ^4F_{9/2}$	7611.442	−0.504		
123219.200	$(^3H)4f$	5[8]	17/2	103644.800	$(^3H)4d\ ^4K_{17/2}$	5107.290	−0.983		
				103706.530	$(^3H)4d\ ^4K_{15/2}$	5123.448	+0.347	5123.45	lab
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5168.969	+0.064		blend
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5234.285	+0.991	5234.283	lab
123193.090	$(^3H)4f$	5[8]	15/2	103706.530	$(^3H)4d\ ^4K_{15/2}$	5130.313	−0.507		
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5163.574	+0.908	5163.55	lab
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5175.957	−0.540	5175.95	
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5226.368	−0.216		blend
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5241.450	−0.301	5241.465	lab
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5295.776	−0.452	5295.773	
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5383.304	+0.146	5383.32	blend

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy levels as upper levels

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
123238.440	$(^3H)4f$	5[7]	15/2	103617.580	$(^3H)4d\ ^4H_{13/2}$	5095.196	−0.836	5095.19	
				103706.530	$(^3H)4d\ ^4K_{15/2}$	5118.401	−0.254	5118.40	lab
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5151.507	−0.716		blend
				103878.370	$(^3H)4d\ ^4I_{15/2}$	5163.831	−0.599	5163.82	lab
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5214.007	+0.873	5214.99	blend
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5229.017	−0.045	5229.030	lab
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5283.085	+0.323	5283.093	lab
				105288.850	$(^3F)4d\ ^4H_{13/2}$	5569.611	−1.005		blend
123168.680	$(^3H)4f$	5[7]	13/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	5108.895	−1.165		
				103706.530	$(^3H)4d\ ^4K_{15/2}$	5136.747	−1.256		
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5148.687	+0.010	5148.7	lab
				103832.050	$(^3H)4d\ ^4K_{11/2}$	5170.092	−1.170		
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5208.267	−0.275	5208.268	computed too weak
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5233.046	+0.138	5233.041	
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5263.242	−0.600		
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5302.633	−0.581		
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5390.389	+0.010	5390.38	computed too strong
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5432.319	+0.495	5432.31	lab
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5521.763	−0.481	5521.78	
				105398.850	$(^3F)4d\ ^4H_{11/2}$	5625.954	−1.425		
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5743.747	−0.321	5743.75	computed too strong
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5838.483	−0.311		
				108630.429	$(^1I)5s\ e^2I_{11/2}$	6876.509	−1.228		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	7413.385	−0.848		
123249.650	$(^3H)4f$	5[6]	13/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	5087.842	−0.510	5087.85	lab
				103706.530	$(^3H)4d\ ^4K_{15/2}$	5115.465	−1.027		
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5127.305	+0.392	5127.32	lab, blend
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5148.533	+0.357	5148.52	lab
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5186.389	+0.210	5186.396	lab
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5210.960	−0.403	5210.964	
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5225.953	−0.742		blend
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5240.901	−0.464	5240.911	
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5279.957	−0.647		blend
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5366.958	+0.032	5366.95	lab
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5497.178	−1.156		
				105288.850	$(^3F)4d\ ^4H_{13/2}$	5566.135	−1.260		
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5717.150	−0.553	5717.18	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5811.004	−0.182	5811.00	
				109049.600	$(^3G)4d\ ^2I_{13/2}$	7040.287	−1.496		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	7369.139	−1.023		
123270.340	$(^3H)4f$	5[6]	11/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	5082.491	−0.827		blend
				103683.070	$(^3H)4d\ ^4F_{9/2}$	5103.934	−1.365		
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5121.871	+0.373	5121.89	lab
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5127.035	−0.542	5127.05	
				103832.050	$(^3H)4d\ ^4K_{11/2}$	5143.054	−0.456	5143.05	
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5154.246	+0.127	5154.25	lab
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5180.829	−0.529	5180.84	lab
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5205.347	−0.844	5235.225	
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5235.223	−0.536		
				104192.480	$(^3H)4d\ ^4I_{9/2}$	5240.220	−1.229		
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5274.195	−1.310		
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5361.004	−0.422	5361.00	lab

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy levels as upper levels

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
123270.340	cont.			104807.210	$(^3H)4d\ ^2G_{9/2}$	5414.696	−0.589	5414.7	blend
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5446.953	−0.182	5446.95	
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5490.931	−1.162		
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5518.678	−0.927		wrong,not observed
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5710.394	−0.287	5710.40	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5804.025	−0.029	5804.02	
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6041.291	−1.018		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6116.045	−1.092		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	7357.917	−0.867		
123251.470	$(^3H)4f$	5[5]	11/2	103751.660	$(^3H)4d\ ^4H_{11/2}$	5126.827	−0.236		blend
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5132.001	+0.078	5132.0	lab
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5159.265	+0.007	5159.29	lab, blend
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5185.899	+0.058	5185.901	lab
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5210.466	−0.583		
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5240.401	−0.177	5240.405	lab
				104192.480	$(^3H)4d\ ^4I_{9/2}$	5245.408	−1.139		blend
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5279.449	−1.308		
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5407.990	+0.040	5407.99	lab
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5420.234	−1.131		
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5452.558	−0.967	5452.55	
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5496.628	−0.739	5496.62	
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5524.433	−1.032		
				105524.460	$(^3F)4d\ ^4H_{9/2}$	5639.544	−1.347		
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5801.269	−0.770		computed too strong
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5810.389	−1.328		
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5827.945	−0.015	5827.95	computed too weak
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6123.114	−0.236		
				109625.200	$(^3G)4d\ ^2G_{9/2}$	7336.744	−1.064		
				110008.300	$(^3G)4d\ ^2H_{9/2}$	7548.984	−1.185		
123269.378	$(^3H)4f$	5[5]	9/2	103751.660	$(^3H)4d\ ^4H_{11/2}$	5122.123	−1.173		blend
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5127.287	−0.734		blend
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5154.501	+0.418	5154.50	lab
				103921.630	$(^3H)4d\ ^4G_{7/2}$	5167.121	−0.470	5167.1	computed too weak
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5181.086	−0.545	5181.1	blend, computed too weak
				103983.510	$(^3G)5s\ ^2G_{7/2}$	5183.700	−0.079		blend
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5184.458	−0.485	5184.463	computed too strong
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5217.365	−1.017		
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5235.486	−0.560		
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5402.756	−0.812		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5414.977	−0.955		
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5470.281	−1.409		
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5509.211	−0.290	5509.2	
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5539.003	−1.382		
				105524.460	$(^3F)4d\ ^4H_{9/2}$	5633.853	−1.381		
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5795.246	−0.974		
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5821.868	−0.325	5821.88	
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6041.643	−1.431		
				106900.370	$(^3F)4d\ ^2G_{7/2}$	6107.415	−0.980		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6116.405	−0.472		blend
				109625.200	$(^3G)4d\ ^2G_{9/2}$	7327.115	−1.238		
123258.994	$(^3H)4f$	5[4]	9/2	103165.320	$(^3P)4d\ ^4F_{9/2}$	4975.303	−1.479		
				103191.917	$(^3P)4d\ ^2F_{7/2}$	4981.898	−0.587		
				103600.430	$(^3H)4d\ ^4G_{11/2}$	5085.425	−1.404		
				103683.070	$(^3H)4d\ ^4F_{9/2}$	5106.894	−0.960		
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5124.850	+0.047	5124.82	lab

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy level as upper levels

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
123258.994	cont.			103771.320	$(^3H)4d\ ^4G_{9/2}$	5130.020	+0.269	5130.0	lab
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5157.263	−0.663		blend
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5324.070	−0.506		blend
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5418.025	−0.657	5418.02	lab
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5450.323	+0.051	5450.30	wrong, computed too strong
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5494.356	−1.301		
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5512.367	−0.848		
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5522.138	−0.450	5522.10	computed too strong
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5539.264	−1.434		
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5714.098	−0.740	5714.10	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5807.851	−0.440	5807.85	blend
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5825.392	−0.814		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6045.483	−0.970		
				106767.210	$(^3F)4d\ ^4F_{7/2}$	6061.948	−1.148		
				106900.370	$(^3F)4d\ ^2G_{7/2}$	6111.293	−1.488		
				108391.500	$(^3G)4d\ ^4G_{9/2}$	6724.229	−1.436		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	7364.069	−1.370		
				110167.280	$(^3G)4d\ ^4F_{7/2}$	7636.319	−1.343		
123258.021	$(^3H)4f$	5[4]	7/2	102802.312	$(^5D)6s\ ^4D_{5/2}$	4887.246	−1.497		blend
				103002.670	$(^3P)4d\ ^4D_{5/2}$	4935.589	−1.223		blend
				103102.860	$(^3P)4d\ ^4D_{7/2}$	4960.124	−1.397		at the continuum level
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5130.276	−0.633		blend
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5157.521	−0.254		blend
				103921.630	$(^3H)4d\ ^4G_{7/2}$	5170.156	−0.375		blend
				103983.510	$(^3G)5s\ ^2G_{7/2}$	5186.755	−0.078		blend
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5187.514	−0.396	5187.52	
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5220.459	−1.202		computed too strong
				104120.270	$(^5D)5d\ ^6P_{5/2}$	5223.820	−0.829		blend
				104209.610	$(^3H)4d\ ^2F_{5/2}$	5248.321	−0.898		blend
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5349.313	−0.940		wrong, not observed
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5450.611	−1.412		blend
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5473.683	−0.926		blend
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5512.661	+0.003	5512.65	
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5542.490	−1.205		blend
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5799.064	−1.320		blend
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5825.721	−0.559	5825.73	
				106866.760	$(^3F)4d\ ^4F_{5/2}$	6099.124	−1.189		blend
				106900.370	$(^3F)4d\ ^2G_{7/2}$	6111.655	−0.698		blend
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6120.658	−0.942		at the continuum level
				110167.280	$(^3G)4d\ ^4F_{7/2}$	7636.885	−1.434		no spectrum
123235.165	$(^3H)4f$	5[3]	7/2	103191.917	$(^3P)4d\ ^2F_{7/2}$	4987.820	−0.173		
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5136.300	−0.037	5136.30	
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5163.610	−0.154		blend
				103921.630	$(^3H)4d\ ^4G_{7/2}$	5176.274	−0.716	5176.25	
				103983.510	$(^3G)5s\ ^2G_{7/2}$	5192.913	−0.799		blend
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5193.673	−0.887		blend
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5226.698	−1.309		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5330.834	−0.226	5330.81	computed too strong
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5425.030	−0.825	5425.01	
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5457.411	−0.238	5457.40	
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5519.618	−1.438		
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5529.415	−0.668	5529.40	wrong, computed too strong
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5549.523	−1.242		
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5571.298	−1.482		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	6054.160	−1.224		

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy levels as upper levels

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
123235.165	cont.			106767.210	$(^3F)4d\ ^4F_{7/2}$	6070.719	−0.626	6070.71	
				110167.280	$(^3G)4d\ ^4F_{7/2}$	7650.242	−0.970		
				110570.300	$(^3G)4d\ ^2F_{7/2}$	7893.688	−1.448		
123211.159	$(^3H)4f$	5[2]	5/2	103193.917	$(^3P)4d\ ^2F_{7/2}$	4993.801	−0.145	4993.80	computed too strong
				103921.630	$(^3H)4d\ ^4G_{7/2}$	5182.716	−1.163	5182.707	good agreement
				103986.330	$(^3G)5s\ ^2G_{7/2}$	5200.159	−1.442		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5337.666	−0.236		blend
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5487.763	−1.396		blend
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5526.943	−0.560	5526.92	computed too strong
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5578.762	−1.365		at the level of the noise
				106767.210	$(^3F)4d\ ^4F_{7/2}$	6079.581	−0.532	6709.60	good agreement
				106900.370	$(^3F)4d\ ^2G_{7/2}$	6129.215	−1.126		blend
				110167.280	$(^3G)4d\ ^4F_{7/2}$	7664.321	−0.703		in telluric
				110570.300	$(^3G)4d\ ^2F_{7/2}$	7908.679	−1.384		in telluric
123213.323	$(^3H)4f$	5[2]	3/2	102802.312	$(^5D)6s\ ^4D_{5/2}$	4897.949	−1.090	4897.90	at the level of the noise
				103597.402	$(^3P)4d\ ^2D_{5/2}$	5096.480	−1.325		at the level of the noise
				104120.270	$(^5D)5d\ ^6P_{5/2}$	5236.050	−0.269	5236.046	computed too strong
				104209.610	$(^3H)4d\ ^2F_{5/2}$	5260.666	−0.338	5260.682	lab, good agreement
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5362.139	−0.684		wrong, not observed
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5560.475	−1.142		
				105414.180	$(^3F)4d\ ^4G_{5/2}$	5616.690	−1.055		blend
				106796.660	$(^3F)4d\ ^4P_{5/2}$	6089.687	−1.322		blend
				106866.760	$(^3F)4d\ ^4F_{5/2}$	6115.802	−0.758	6115.80	good agreement
				110428.280	$(^3G)4d\ ^4F_{5/2}$	7819.490	−1.269		at the continuum level
123396.250	$(^3H)4f$	4[7]	15/2	103706.530	$(^3H)4d\ ^4K_{15/2}$	5077.377	−1.404		
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5109.953	−0.102	5109.95	lab
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5171.443	+0.259	5171.45	lab
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5239.390	+0.861	5239.394	J78
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5325.048	+0.257	5325.05	J78, lab
123355.490	$(^3H)4f$	4[7]	13/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	5060.583	−1.409		
				103751.660	$(^3H)4d\ ^4H_{11/2}$	5099.623	−0.221	5099.6	lab
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5120.621	−1.170	5120.62	lab, computed too weak
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5158.067	+0.788	5158.05	J78, lab
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5182.370	+0.034	5182.371	lab
				104119.710	$(^3H)4d\ ^2K_{15/2}$	5197.198	−1.475		
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5250.606	−0.778	5250.609	computed too weak
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5336.635	−0.215	5336.62	
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5377.729	−0.165	5377.71	J78, lab, computed too weak
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5682.754	−0.574	5682.75	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5775.473	−0.674		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	7312.092	−1.277		
123414.730	$(^3H)4f$	4[6]	13/2	103751.660	$(^3H)4d\ ^4H_{11/2}$	5084.259	−0.750		
				103832.050	$(^3H)4d\ ^4K_{13/2}$	5105.131	−0.704		
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5142.349	−0.245	5142.35	lab
				104064.670	$(^3H)4d\ ^4I_{13/2}$	5166.504	−0.525		blend
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5195.934	+0.922	5195.942	lab
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5234.320	−0.791		blend
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5319.812	−1.134		
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5360.646	−0.638	5360.65	computed too weak
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5447.727	−1.416		
				105398.850	$(^3F)4d\ ^4H_{11/2}$	5549.118	−1.185		
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5755.774	−1.242		

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy levels as upper levels

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
123427.119	$(^3H)4f$	4[6]	11/2	103771.320	$(^3H)4d\ ^4G_{9/2}$	5086.139	−0.441	5086.15	
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5112.917	−0.423		blend
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5139.074	+0.124	5139.10	
				104192.480	$(^3H)4d\ ^4I_{9/2}$	5197.506	+0.465	5197.56	blend
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5230.927	−1.051		
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5316.307	−1.253		
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5357.088	+0.165	5357.10	J78,lab
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5369.102	−1.260		
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5444.051	−0.902		
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5659.712	−0.911		
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5742.735	−0.704		computed too strong
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5751.672	−1.454		
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5768.874	−0.115	5768.90	J78, computed too weak
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5984.595	−1.089		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6057.941	−0.358	6057.92	blend
				109625.200	$(^3G)4d\ ^2G_{9/2}$	7243.378	−1.142		
				110008.300	$(^3G)4d\ ^2H_{9/2}$	7450.174	−1.329		
123441.100	$(^3H)4f$	4[5]	11/2	103771.320	$(^3H)4d\ ^4G_{9/2}$	5082.524	−0.439	5082.51	computed too strong
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5109.263	+0.037	5109.29	lab
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5135.383	−1.089		
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5188.822	+0.224	5188.831	lab
				104192.480	$(^3H)4d\ ^4I_{9/2}$	5193.731	+0.573	5193.74	J78, lab
				104315.370	$(^3H)4d\ ^2K_{13/2}$	5227.103	−1.390		
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5353.077	−0.299		blend
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5439.910	−1.230		
				105524.460	$(^3F)4d\ ^4H_{9/2}$	5579.854	−1.306		
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5738.126	−1.011		computed too strong, not obs
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5764.224	−0.455	5764.20	
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5979.588	−1.109		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6052.813	−0.460	6052.8	
				109625.200	$(^3G)4d\ ^2G_{9/2}$	7236.043	−1.361		
123435.468	$(^3H)4f$	4[5]	9/2	103921.630	$(^3H)4d\ ^4G_{7/2}$	5123.141	+0.119	5123.190	blend
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5136.869	−0.836		blend
				103983.510	$(^3G)5s\ ^2G_{7/2}$	5139.439	+0.314		blend
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5140.184	−0.208	5140.2	lab
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5172.529	−1.242		
				104174.270	$(^3H)4d\ ^4I_{11/2}$	5190.340	−1.319		
				104192.480	$(^3H)4d\ ^4I_{9/2}$	5195.251	+0.450	5195.26	lab
				105589.670	$(^3F)4d\ ^4H_{7/2}$	5602.005	−1.242		
123460.690	$(^3H)4f$	4[4]	9/2	103191.917	$(^3P)4d\ ^2F_{7/2}$	4932.321	−1.442		
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5077.467	−0.602	5077.5	lab
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5104.153	−0.047	5104.15	
				103921.630	$(^3H)4d\ ^4G_{7/2}$	5116.528	−0.613	5116.52	
				103973.780	$(^3H)4d\ ^4K_{11/2}$	5130.220	−1.289		
				103983.510	$(^3G)5s\ ^2G_{7/2}$	5132.783	−0.961		
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5133.527	−0.989		
				104174.27	$(^3H)4d\ ^4I_{11/2}$	5183.552	−0.937		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5267.488	−0.494	5267.47	
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5347.468	−0.307	5347.45	lab
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5359.439	−1.442		
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5413.610	−0.234	5413.60	lab
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5434.117	−1.217		
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5451.734	−0.292	5451.72	
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5480.906	−0.700		blend
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5502.146	−0.769		
				105449.540	$(^5D)5d\ ^4G_{7/2}$	5550.575	−1.270		

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy levels as upper levels

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
123460.690	cont.			106018.640	$(^3F)4d\ ^2H_{9/2}$	5731.681	−0.446		wrong, not observed
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5757.720	+0.118	5757.72	J78, computed too low
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5972.589	−0.946		
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5988.704	−1.212		
				106900.370	$(^3F)4d\ ^2G_{7/2}$	6036.859	−0.912		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6045.643	−0.124	6045.65	
				109625.200	$(^3G)4d\ ^2G_{9/2}$	7225.797	−0.960		
				110008.300	$(^3G)4d\ ^2H_{9/2}$	7431.576	−1.109		
123435.277	$(^3H)4f$	4[4]	7/2	103921.630	$(^3H)4d\ ^4G_{7/2}$	5123.191	−0.068		blend
				103983.510	$(^3G)5s\ ^2G_{7/2}$	5139.489	+0.217	5139.45	lab, blend
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5140.234	−0.435	5140.20	blend
				104023.910	$(^3H)4d\ ^4G_{5/2}$	5150.186	+0.144	5150.15	lab
				104120.270	$(^5D)5d\ ^6P_{5/2}$	5175.880	−1.206		blend
				104192.480	$(^3H)4d\ ^4I_{9/2}$	5195.303	−0.325		blend
				104209.610	$(^3H)4d\ ^2F_{5/2}$	5199.932	−1.066	5199.95	computed too weak
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5299.053	−0.753		computed too strong
				105414.180	$(^3F)4d\ ^4G_{5/2}$	5547.511	−1.009		at the level of the noise
				105589.670	$(^3F)4d\ ^4H_{7/2}$	5602.065	−1.328		blend
				105630.750	$(^5D)5d\ ^4G_{5/2}$	5614.990	−1.423		at the continuum level
				107407.800	$(^3F)4d\ ^2D_{5/2}$	6237.560	−1.471		at the continuum level
123451.449	$(^3H)4f$	4[3]	7/2	103191.917	$(^3P)4d\ ^2F_{7/2}$	4934.571	−1.453		
				103597.402	$(^3P)4d\ ^2D_{5/2}$	5035.352	−0.856		
				103771.320	$(^3H)4d\ ^4G_{9/2}$	5079.851	−1.218		
				103874.260	$(^3H)4d\ ^4H_{9/2}$	5106.563	−0.583	5106.55	
				103921.630	$(^3H)4d\ ^4G_{7/2}$	5118.949	−1.061		
				103983.510	$(^3G)5s\ ^2G_{7/2}$	5135.220	−0.335		
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5135.964	−1.420	5135.95	
				104023.910	$(^3H)4d\ ^4G_{5/2}$	5145.899	−0.764		
				104107.950	$(^3P)4d\ ^4F_{7/2}$	5168.256	−1.230		
				104120.270	$(^5D)5d\ ^6P_{5/2}$	5171.550	−1.408		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5270.054	−0.654		blend
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5294.515	−1.314		
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5416.320	−0.276	5416.32	lab
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5454.483	−0.324	5454.50	blend
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5483.684	−0.695		
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5504.945	−0.792	5504.95	
				105449.540	$(^5D)5d\ ^4G_{7/2}$	5553.424	−1.292		
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5734.719	−1.053		
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5760.786	−0.536	5760.78	computed too weak
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5992.021	−1.212		
				106900.370	$(^3F)4d\ ^2G_{7/2}$	6040.230	−1.110		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	6049.023	−0.751		
123430.181	$(^3H)4f$	4[3]	5/2	103597.402	$(^3P)4d\ ^2D_{5/2}$	5040.752	−1.238		blend
				103921.630	$(^3H)4d\ ^4G_{7/2}$	5124.529	−0.535	5124.52	
				103983.510	$(^3G)5s\ ^2G_{7/2}$	5140.836	−0.648	5140.83	
				103986.330	$(^3H)4d\ ^4H_{7/2}$	5141.582	−0.884		blend
				104023.910	$(^3H)4d\ ^4G_{5/2}$	5151.538	+0.030	5151.52	J78, lab
				104120.270	$(^5D)5d\ ^6P_{5/2}$	5177.246	−0.906		blend
				104209.610	$(^3H)4d\ ^2F_{5/2}$	5201.311	−0.851		blend, wrong ?
				104569.230	$(^3P)4d\ ^4F_{5/2}$	5300.485	−0.786		blend, computed too strong
				104572.920	$(^3P)4d\ ^4F_{3/2}$	5301.522	−0.742		wrong, not observed
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5422.568	−1.395		at the continuum level
				105317.440	$(^3P)4d\ ^2P_{3/2}$	5519.442	−1.271	5519.43	at the level of the noise

Table 7. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3H)4f$ energy levels as upper levels

Upper level			Lower level		λ(calc)	$log\,gf$	λ(obs)	Notes
cm^{-1}		J	cm^{-1}		Å	KUR	Å	
123430.181	cont.		105379.430	$(^3F)4d\ ^4D_{5/2}$	5538.397	−1.442		at the level of the noise
			105414.180	$(^3F)4d\ ^4G_{5/2}$	5549.080	−0.905		blend
			105630.750	$(^5D)5d\ ^4G_{5/2}$	5616.598	−1.451		blend
			106846.650	$(^3F)4d\ ^4F_{3/2}$	6028.409	−1.085	6028.40	at the level of the noise
			106866.760	$(^3F)4d\ ^4F_{5/2}$	6035.729	−1.269		
			107407.800	$(^3F)4d\ ^2D_{5/2}$	6239.544	−1.446		
			110428.280	$(^3G)4d\ ^4F_{5/2}$	7689.067	−1.409		
			110609.540	$(^3G)4d\ ^4F_{3/2}$	7797.776	−1.406		

Table 8. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3F)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	K09	Å	
124421.468	$(^3F)4f$	4[7]	15/2	103617.580	$(^3H)4d\ ^4H_{13/2}$	4805.451	−0.972	4805.42	
				104064.670	$(^3H)4d\ ^4I_{13/2}$	4910.993	−1.090		at the continuum level
				104119.710	$(^3H)4d\ ^2K_{15/2}$	4924.307	−1.174		not obs
				104622.300	$(^3H)4d\ ^2I_{13/2}$	5049.309	−1.258	5049.3	very weak
				105288.847	$(^3F)4d\ ^4H_{13/2}$	5225.221	+0.974	5225.229	lab, J78
124436.436	$(^3F)4f$	4[7]	13/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	4798.043	−1.190		at the continuum level
				103751.660	$(^3H)4d\ ^4H_{11/2}$	4833.123	−1.441		
				104315.370	$(^3H)4d\ ^2K_{13/2}$	4968.529	−1.078	4968.53	very weak
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5082.213	−1.265		blend
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5160.416	−0.003	5160.4	lab
				105288.847	$(^3F)4d\ ^4H_{13/2}$	5221.136	−0.831		blend,weak component
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5251.306	+0.664	5251.321	blend
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5353.789	+0.076	5353.80	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5436.006	−0.154	5436.12	
				108630.429	$(^1I)5s\ e^2I_{11/2}$	6324.960	−1.433		at the continuum level
124400.107	$(^3F)4f$	4[6]	13/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	4806.424	−0.542	4806.4	
				104174.270	$(^3H)4d\ ^4I_{11/2}$	4942.792	−1.458		very weak
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5091.616	−0.517	5091.6	
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5170.111	+0.742	5170.10	J78,lab, blended
				105288.850	$(^3F)4d\ ^4H_{13/2}$	5231.062	+0.278	5231.067	lab
				105398.850	$(^3F)4d\ ^4H_{11/2}$	5261.345	+0.080	5261.339	shifted ?
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5364.226	−0.538	5364.22	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5446.766	−0.314	5446.75	blend
124402.557	$(^3F)4f$	4[6]	11/2	103683.070	$(^5D)5d\ ^4F_{9/2}$	4825.028	−1.407		
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5090.983	−1.256		blend
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5101.830	−1.382	5101.82	
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5130.460	+0.158		
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5169.456	−0.871		computed too strong
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5194.042	−0.084	5194.047	
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5209.193	−0.494	5209.199	
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5260.668	−0.049	5260.682	
				105524.461	$(^3F)4d\ ^4H_{9/2}$	5295.671	−1.274	5295.662	computed too weak
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5363.520	−0.269	5363.51	
				106018.643	$(^3F)4d\ ^2H_{9/2}$	5438.027	−0.914		blend
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5446.039	−0.626	5446.05	
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5461.459	+0.179	5461.48	
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5654.418	−0.044		computed too strong
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5719.850	+0.097	5719.85	lab,J78
				109925.200	$(^3G)4d\ ^2G_{9/2}$	6765.246	−1.049		
				110008.300	$(^3G)4d\ ^2H_{9/2}$	6945.303	−1.190		
124388.840	$(^3F)4f$	4[5]	11/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	4809.029	−0.852	4809.02	
				103683.070	$(^5D)5d\ ^4F_{9/2}$	4828.222	−0.829		
				103771.320	$(^3H)4d\ ^4G_{9/2}$	4848.889	−0.699		weak, on the H_β wing
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5094.540	−0.517	5094.55	lab
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5105.404	+0.158	5105.4	
				104868.500	$(^5D)5d\ ^6G_{9/2}$	5121.435	−0.968	5121.45	weak
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5134.072	−0.161		blend
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5173.126	+0.425	5173.12	lab
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5197.747	−0.166	5197.756	
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5212.916	−0.199		blend
				105288.847	$(^3F)4d\ ^4H_{13/2}$	5234.147	−0.630		blend
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5264.468	−0.717	5264.45	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5450.112	−1.282		blend
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5658.806	−0.643		blend
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5724.343	−0.429		blend, computed too strong
				109811.920	$(^3G)4d\ ^4F_{9/2}$	6858.267.	−0.903		at the continuum level

Table 8. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3F)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	K09	Å	
124385.706	$(^3F)4f$	4[5]	9/2	103771.320	$(^3H)4d\ ^4G_{9/2}$	4849.626	−1.159		H_β wing, not obs.
				103986.330	$(^3H)4d\ ^4H_{7/2}$	4900.742	−1.404		at the continuum level
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5106.222	−0.305		
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5155.371	−0.195	5155.37	computed too strong
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5173.965	−0.955	5173.98	computed too weak
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5189.933	−0.112		blend
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5198.594	−0.154	5198.596	
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5213.769	−0.389	5213.78	
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5216.634	−1.420		
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5235.599	−0.769		blend
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5265.337	−0.986	5265.323	
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5371.899	+0.199	5371.90	
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5443.015	−1.240		
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5466.492	−0.492	5466.49	blend
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5659.810	−1.436		blend
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5674.279	−1.037	5674.30	
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5717.492	−1.080		blend
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5725.370	−0.147	5725.35	
				110167.280	$(^3G)4d\ ^4F_{7/2}$	7031.188	−1.480		not observed
				110570.300	$(^3G)4d\ ^2F_{7/2}$	7236.302	−1.125		not observed
124401.939	$(^3F)4f$	4[4]	9/2	103683.070	$(^5D)5d\ ^4F_{9/2}$	4825.170	−0.851		
				103771.320	$(^3H)4d\ ^4G_{9/2}$	4845.810	−1.216		on the H_β wing
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5018.593	−0.782		blend Fe II 5018.440
				104765.450	$(^3H)4d\ ^2I_{11/2}$	5091.141	−1.199	5091.15	
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5101.991	−0.285		wrong,not observed
				104868.500	$(^5D)5d\ ^6G_{9/2}$	5118.000	−0.871	5117.98	
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5130.621	+0.114	5130.60	lab
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5151.058	−0.280	5151.07	lab
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5169.622	−0.361	5169.6	
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5194.209	−1.245		blend Fe III
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5209.359	−1.260		
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5211.949	+0.055	5211.953	lab
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5231.152	−0.836		blend
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5363.698	−1.391		blend
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5367.218	−0.182	5367.22	
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5461.644	−0.455	5461.65	
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5654.613	−0.197	5654.62	
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5712.189	−1.361		at the level of the noise
				109811.920	$(^3G)4d\ ^4F_{9/2}$	6852.110	−0.955		at the level of the noise
124385.010	$(^3F)4f$	4[4]	7/2	103191.917	$(^3P)4d\ ^2F_{7/2}$	4717.199	−1.461		
				103597.402	$(^3P)4d\ ^2D_{5/2}$	4809.214	−1.233		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5106.403	−1.091		
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5155.556	−0.412	5155.56	
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5190.121	−0.246	5190.123	
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5198.782	−0.950		blend
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5213.958	−1.188		blend
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5216.553	−1.332		blend
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5220.268	−1.463		
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5235.790	−0.829		blend
				105775.836	$(^3F)4d\ ^2F_{7/2}$	5372.100	+0.165	5372.10	lab
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5466.700	−1.095		at the level of the noise
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5500.096	−0.922		blend
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5674.503	−1.298	5674.50	computed too weak
				106796.660	$(^3F)4d\ ^4P_{5/2}$	5684.004	−0.895		
				106866.760	$(^3F)4d\ ^4F_{5/2}$	5706.743	−0.920		
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5717.719	−1.023		not observed

Table 8. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3F)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	*log gf*	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	K09	Å	
124385.010	cont.			106924.430	$(^3F)4d\ ^2G_{9/2}$	5725.598	−0.824	5725.60	
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5888.617	−0.044	5888.61	
				110570.300	$(^3G)4d\ ^2F_{7/2}$	7236.667	−1.221		at the level of the noise
124416.110	$(^3F)4f$	4[3]	7/2	103683.070	$(^5D)5d\ ^4F_{9/2}$	4821.172	−1.273		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5015.025	−0.607	5015.02	
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5098.304	−0.623		
				104868.500	$(^5D)5d\ ^6G_{9/2}$	5114.290	−1.355		computed too strong
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5126.892	−0.477	5126.84	lab, blend
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5147.300	+0.051	5147.25	blend,lab
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5181.754	−1.028	5181.75	computed too weak
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5190.388	−1.077		blend
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5205.515	−1.184		blend
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5208.101	+0.031	5208.99	
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5227.276	−1.201		blend
				105379.430	$(^3F)4d\ ^4D_{5/2}$	5251.555	−1.289		at the continuum level
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5363.137	−0.687	5363.15	
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5457.419	−1.335		blend
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5650.084	−0.819		blend
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5664.504	−1.029		at the level of the noise
				106796.660	$(^3F)4d\ ^4P_{5/2}$	5673.972	−0.486	5673.93	blend
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5877.850	−1.281		at the level of the noise
				109811.920	$(^3G)4d\ ^4F_{9/2}$	6845.461	−1.364		not observed
124403.474	$(^3F)4f$	4[3]	5/2	103597.402	$(^3P)4d\ ^2D_{5/2}$	4804.946	−1.146	4804.93	computed too weak
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5150.651	−0.855		
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5185.150	−0.746	5185.141	lab,blend
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5215.240	−1.455		blend
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5230.732	−1.416		blend
				105317.440	$(^3P)4d\ ^2P_{3/2}$	5237.975	−1.304		blend
				105460.230	$(^3F)4d\ ^4D_{3/2}$	5277.458	−0.778		wrong, not observed
				105518.140	$(^3H)4d\ ^4F_{3/2}$	5293.641	−1.294	5293.627	computed too low ?
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5366.775	−0.450	5366.78	
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5494.515	−0.721	5494.51	
				106796.660	$(^3F)4d\ ^4P_{5/2}$	5678.044	−1.006		computed too strong
				106866.760	$(^3F)4d\ ^4F_{5/2}$	5700.741	−0.790	5700.76	
				107065.900	$(^3F)4d\ ^4P_{3/2}$	5766.220	−1.192		at the level of the noise
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5882.220	−0.040	5882.22	
				107430.250	$(^3F)4d\ ^2D_{3/2}$	5890.000	−0.918		blend Na I
				108105.900	$(^3F)4d\ ^2P_{3/2}$	6134.185	−0.702	6134.2	
				110611.800	$(^3G)4d\ ^2F_{5/2}$	7248.754	−1.434		blend with telluric
124434.563	$(^3F)4f$	4[2]	5/2	103597.402	$(^3P)4d\ ^2D_{5/2}$	4797.777	−1.440		
				104120.270	$(^5D)5d\ ^6P_{5/2}$	4921.269	−0.982		blend
				104209.610	$(^3H)4d\ ^2F_{5/2}$	4943.008	−1.371	4943.0	
				104481.590	$(^3H)4d\ ^2F_{7/2}$	5010.387	−0.817	5010.4	
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5142.414	−0.113	5142.42	lab
				105213.000	$(^3H)4d\ ^2G_{7/2}$	5176.803	−1.156		blend
				105127.770	$(^5D)5d\ ^4D_{5/2}$	5178.082	−1.132	5178.08	computed too weak
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5203.100	−0.191	5203.10	
				105379.430	$(^3F)4d\ ^4D_{5/2}$	5246.469	−0.830		at the noise level, computed too strong
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5357.833	−1.105		
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5485.142	−1.413		
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5658.587	−1.147		blend
				106796.660	$(^3F)4d\ ^4P_{5/2}$	5668.035	−0.132	5668.05	computed too strong
				106866.760	$(^3F)4d\ ^4F_{5/2}$	5690.652	−1.300	5690.68	computed too weak
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5871.480	−1.133		

Table 8. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3F)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$log\,gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	K09	Å	
124460.410	$(^3F)4f$	4[2]	3/2	104120.270	$(^5D)5d\ ^6P_{5/2}$	4915.015	−1.449		
				104189.380	$(^5D)5d\ ^4P_{3/2}$	4931.772	−1.122		wrong,not observed
				105234.060	$(^3H)4d\ ^4F_{5/2}$	5199.747	−1.496		
				105317.440	$(^3P)4d\ ^2P_{3/2}$	5222.396	−0.923		blend
				105379.430	$(^3F)4d\ ^4D_{5/2}$	5239.362	−1.350		blend
				105460.230	$(^3F)4d\ ^4D_{3/2}$	5261.644	−0.436		wrong, not observed
				105518.140	$(^3H)4d\ ^4F_{3/2}$	5277.730	−1.098		blend
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5477.375	−1.153		at the level of the noise
				106846.650	$(^3F)4d\ ^4F_{3/2}$	5675.805	−1.332		at the level of the noise
				106866.760	$(^3F)4d\ ^4F_{5/2}$	5682.292	−0.926		at the level of the noise
				107065.930	$(^3F)4d\ ^4P_{3/2}$	5747.356	−0.824		at the level of the noise
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5862.580	−0.452	5862.58	at the level of thec noise
				107430.250	$(^3F)4d\ ^2D_{3/2}$	5870.308	−0.663	5870.30	computed too weak
				108105.900	$(^3F)4d\ ^2P_{3/2}$	6112.829	−0.452		EMISSION ?
124661.274	$(^3F)4f$	3[6]	13/2	103751.660	$(^3H)4d\ ^4H_{11/2}$	4781.152	−1.241	4781.15	computed too weak
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5101.212	−1.511	5101.2	computed too weak
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5190.010	+0.482	5190.012	
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5290.092	+0.589	5290.094	
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5370.350	+0.111	5370.3	Fe II,5270.284 main comp.
124656.535	$(^3F)4f$	3[6]	11/2	103874.260	$(^3H)4d\ ^4H_{9/2}$	4810.449	−1.268	4810.45	weak
				104192.480	$(^3H)4d\ ^4I_{9/2}$	4885.254	−1.238		blend
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5126.398	−0.847		very weak
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5191.288	−1.025		blend
				105524.461	$(^3F)4d\ ^4H_{9/2}$	5225.371	+0.768	5225.364	lab + unid
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5291.420	−1.047		very weak
				106018.643	$(^3F)4d\ ^2H_{9/2}$	5363.923	+0.201	5363.92	lab
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5574.341	−1.111	5574.25	
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5637.925	−0.160	5637.92	
				109625.200	$(^3G)4d\ ^2G_{9/2}$	6650.935	−1.387		blend
124626.900	$(^3F)4f$	3[5]	11/2	103683.070	$(^5D)5d\ ^4F_{9/2}$	4773.341	−1.317		
				103771.320	$(^3H)4d\ ^4G_{9/2}$	4793.540	−0.748	4793.55	
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5044.081	−0.396		wrong, not observed
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5072.063	−0.515	5072.05	
				105063.550	$(^3F)4d\ ^4G_{11/2}$	5110.175	−1.355		blend
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5134.199	+0.353	5134.20	blend
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5149.000	−0.004		blend
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5199.288	−0.178	5199.29	
				105524.461	$(^3F)4d\ ^4H_{9/2}$	5233.477	−0.662	5233.47	computed too weak
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5299.732	−0.158	5299.717	lab
				106018.643	$(^3F)4d\ ^2H_{9/2}$	5372.464	−0.223		blend
				106045.690	$(^3H)4d\ ^2H_{11/2}$	5380.285	−0.656	5380.29	
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5395.335	+0.054	5395.32	computed too strong
				106722.170	$(^3F)4d\ ^4F_{9/2}$	5583.566	−1.347		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5647.362	−0.074		blend
				109811.920	$(^3G)4d\ ^4F_{9/2}$	6748.062	−1.222		at the level of the noise
124636.116	$(^3F)4f$	3[5]	9/2	103771.320	$(^3H)4d\ ^4G_{9/2}$	4791.423	−1.349		at the level of the noise
				104107.950	$(^3P)4d\ ^4F_{7/2}$	4869.996	−1.378		blend
				104481.590	$(^3H)4d\ ^2F_{7/2}$	4960.280	−1.109	4960.28	weak
				104807.210	$(^3H)4d\ ^2G_{9/2}$	5041.737	−1.101		weak
				104873.230	$(^5D)5d\ ^4D_{7/2}$	5058.579	−1.461		weak
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5069.692	−1.055		weak

Table 8. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3F)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	K09	Å	
124636.116	cont.			104993.860	$(^3F)4d\ ^4D_{7/2}$	5089.646	−0.797		weak
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5123.331	−1.032		
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5131.770	−0.298		blend
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5146.557	−0.622		blend
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5149.085	+0.286	5149.1	lab
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5167.827.	−0.884	5167.82	computed too weak
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5196.797	−1.467		at the level of the noise
				105524.461	$(^3F)4d\ ^4H_{9/2}$	5230.953	−0.507	5230.959	computed too weak
				105589.670	$(^3F)4d\ ^4H_{7/2}$	5248.862	−0.754	5248.801	blend
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5297.144	−1.481		weak
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5300.576	−0.373		weak
				106018.643	$(^3F)4d\ ^2H_{9/2}$	5369.805	−0.547	5369.81	
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5392.652	−0.592		not obs, wrong
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5594.760	−0.050		not obs, wrong
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5636.766	−0.061	5636.78	computed too weak
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5644.423	−0.918		blend
				109901.500	$(^3G)4d\ ^2G_{7/2}$	6784.867	−1.141		at the level of the noise
				110167.280	$(^3G)4d\ ^4F_{7/2}$	6909.500	−1.099		at the level of the noise
124623.120	$(^3F)4f$	3[4]	9/2	103921.630	$(^3H)4d\ ^4G_{7/2}$	4829.221	−1.017	4829.25	computed too weak
				103983.510	$(^3G)5s\ ^2G_{7/2}$	4843.700	−1.308		computed too strong, not obs
				103986.330	$(^3H)4d\ ^4H_{7/2}$	4844.361	−1.133		
				104916.550	$(^3H)4d\ ^4F_{9/2}$	5073.036	−1.028		
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5093.016	−1.142	5093.01	weak
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5126.745	−0.382	5126.75	lab, blend
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5135.196	−0.318		blend
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5150.003	−0.755	5150.02	
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5152.534	−1.333		blend
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5171.301	+0.425	5171.305	
				105398.852	$(^3F)4d\ ^4H_{11/2}$	5200.310	−1.359		blend
				105449.540	$(^5D)5d\ ^4G_{7/2}$	5214.058	−0.628		blend
				105524.461	$(^3F)4d\ ^4H_{9/2}$	5234.513	−0.157		blend
				105763.270	$(^3F)4d\ ^2H_{11/2}$	5300.794	−1.386		blend
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5304.231	−0.076	5304.25	blend
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5373.555	−1.277		
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5396.435	−0.899	5396.45	computed too weak
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5640.900	−0.389	5640.9	computed too strong
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5648.568	−0.369	5648.57	blend
				110570.300	$(^3G)4d\ ^2F_{7/2}$	7114.048	−1.243		
124620.914	$(^3F)4f$	3[4]	7/2	103921.630	$(^3H)4d\ ^4G_{7/2}$	4829.735	−1.435		
				104023.910	$(^3H)4d\ ^4G_{5/2}$	4853.719	−0.883		
				104569.230	$(^3P)4d\ ^4F_{5/2}$	4985.721	−0.873	4985.72	weak
				104993.860	$(^3F)4d\ ^4D_{7/2}$	5093.588	−1.437		blend
				105123.000	$(^3H)4d\ ^2G_{5/2}$	5127.325	−0.784		blend
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5135.778	−1.386		weak
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5156.745	−0.254		blend
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5171.891	+0.011	5171.9	
				105379.430	$(^3F)4d\ ^4D_{5/2}$	5195.658	−0.478	5195.661	lab
				105414.180	$(^3F)4d\ ^4G_{5/2}$	5205.058	−0.783		blend
				105449.540	$(^5D)5d\ ^4G_{7/2}$	5214.658	−1.042		weak
				105524.461	$(^3F)4d\ ^4H_{9/2}$	5235.117	−1.185		blend
				105711.730	$(^5D)5d\ ^6S_{5/2}$	5286.964	−0.934		blend
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5304.852	−0.525	5304.87	blend
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5429.627	−0.531	5429.62	computed too weak
				106866.760	$(^3F)4d\ ^4F_{5/2}$	5630.922	−1.421		weak
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5641.602	−0.724	5641.61	weak
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5649.272	−1.404		not observed
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5807.914	−0.295	5807.9	blend

Table 8. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3F)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	K09	Å	
124641.989	$(^3F)4f$	3[3]	7/2	104107.950	$(^3P)4d\ ^4F_{7/2}$	4868.603	−1.393		
				104120.270	$(^5D)5d\ ^6P_{5/2}$	4871.525	−1.423		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	4958.835	−1.370		blend
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5121.789	−0.828		
				105155.090	$(^3F)4d\ ^4G_{9/2}$	5130.223	−0.928		blend
				105211.062	$(^5D)5d\ ^4G_{9/2}$	5145.002	−1.290		at the level of the noise
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5147.528	−0.014	5147.52	
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5166.258	−1.096		weak
				105379.430	$(^3F)4d\ ^4D_{5/2}$	5189.973	−0.210		blend
				105414.180	$(^3F)4d\ ^4G_{5/2}$	5199.353	−1.041		blend
				105589.670	$(^3F)4d\ ^4H_{7/2}$	5247.244	−0.996	5247.25	weak
				105711.730	$(^5D)5d\ ^6S_{5/2}$	5281.078	−0.874		not observed
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5298.926	−0.405		blend
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5390.945	−1.384		blend
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5423.419	−0.138	5423.41	lab
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5592.922	−0.422		wrong
				106796.660	$(^3F)4d\ ^4P_{5/2}$	5602.152	−0.795		blend
				106866.760	$(^3F)4d\ ^4F_{5/2}$	5624.245	−1.195		blend
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5634.900	−0.588	5634.9	computed too weak
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5642.552	−1.377		at the level of the noise
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5800.811	−0.993		at the level of the noise
				110167.280	$(^3G)4d\ ^4F_{7/2}$	6906.696	−1.294		at the level of the noise
				110611.800	$(^3G)4d\ ^2F_{5/2}$	7125.523	−1.233		at the level of the noise
124653.022	$(^3F)4f$	3[3]	5/2	104023.910	$(^3H)4d\ ^4G_{5/2}$	4846.164	−1.115		weak
				104569.230	$(^3P)4d\ ^4F_{5/2}$	4977.751	−0.819	4977.75	computed too weak
				104839.998	$(^3P)4d\ ^2D_{3/2}$	5045.778	−0.981	5045.79	computed too weak
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5118.896	−1.484		
				105234.237	$(^3H)4d\ ^4F_{5/2}$	5148.219	−0.286		computed too strong
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5163.314	−0.700	5163.29	weak
				105317.440	$(^3P)4d\ ^2P_{3/2}$	5170.372	−1.129		
				105379.430	$(^3F)4d\ ^4D_{5/2}$	5187.002	−0.628	5187.0	
				105414.180	$(^3F)4d\ ^4G_{5/2}$	5196.371	−0.956		blend
				105460.230	$(^3F)4d\ ^4D_{3/2}$	5208.839	−0.132	5208.862	lab, computed too strong
				105711.730	$(^5D)5d\ ^6S_{5/2}$	5278.002	−1.442		
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5295.829	−1.021		blend
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5420.175	−0.824	5420.2	computed too weak
				106846.650	$(^3F)4d\ ^4F_{3/2}$	5614.409	−0.773		computed too strong
				107065.930	$(^3F)4d\ ^4P_{3/2}$	5684.411	−1.018		
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5797.100	−0.273	5797.1	
				107430.250	$(^3F)4d\ ^2D_{3/2}$	5804.657	−0.981		at the level of the noise
				108105.900	$(^3F)4d\ ^2P_{3/2}$	6041.674	−0.519		
124731.762	$(^3F)4f$	3[0]	1/2	104189.380	$(^5D)5d\ ^4P_{3/2}$	4866.625	−0.710		on the H_β wing
				104588.710	$(^5D)5d\ ^6D_{3/2}$	4963.106	−1.473		
				104736.460	$(^3P)4d\ ^2P_{1/2}$	4999.780	−1.476		
				105460.230	$(^3F)4d\ ^4D_{3/2}$	5187.556	−1.137		
				105477.920	$(^3F)4d\ ^4D_{1/2}$	5192.323	−0.902		blend
				105518.140	$(^3H)4d\ ^4F_{3/2}$	5203.192	−0.854		blend
				107065.930	$(^3F)4d\ ^4P_{3/2}$	5659.074	−0.650	5659.05	computed too weak
				107176.100	$(^5D)5d\ ^4P_{1/2}$	5694.588	−0.810	5694.59	good agreement
				107430.250	$(^3F)4d\ ^2D_{3/2}$	5778.239	−0.939		blend
				108105.900	$(^3F)4d\ ^2P_{3/2}$	6013.060	−1.184		

Table 8. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3F)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$log\,gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	K09	Å	
124803.873	$(^3F)4f$	2[5]	11/2	103771.320	$(^3H)4d\ ^4G_{9/2}$	4753.206	−1.359		
				104807.210	$(^3H)4d\ ^2G_{9/2}$	4999.441	−1.315		
				105524.461	$(^3F)4d\ ^4H_{9/2}$	5185.437	+0.377	5185.422	lab
				106018.643	$(^3F)4d\ ^2H_{9/2}$	5321.852	+0.731	5321.83	lab
				106097.520	$(^3H)4d\ ^2H_{9/2}$	5344.292	−1.008	5344.28	
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5591.464	−0.173		computed too strong
				109625.200	$(^3G)4d\ ^2G_{9/2}$	6586.373	−1.344		not observed
124809.727	$(^3F)4f$	2[5]	9/2	103921.630	$(^3H)4d\ ^4G_{7/2}$	4786.078	−1.434		
				103983.510	$(^3G)5s\ ^2G_{7/2}$	4800.298	−1.342		
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5121.860	−1.107		blend
				105449.540	$(^5D)5d\ ^4G_{7/2}$	5163.801	−1.335		blend
				105524.461	$(^3F)4d\ ^4H_{9/2}$	5183.862	−1.227		blend
				105589.670	$(^3F)4d\ ^4H_{7/2}$	5201.450	+0.802	5201.444	lab
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5252.229	−1.121		
				106018.643	$(^3F)4d\ ^2H_{9/2}$	5320.193	−0.866		blend
				106767.210	$(^3F)4d\ ^4F_{7/2}$	5540.925	−1.367		
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5582.123	−0.405	5582.12	
124793.905	$(^3F)4f$	2[4]	9/2	103921.630	$(^3H)4d\ ^4G_{7/2}$	4789.706	−1.174	4789.7	computed too weak
				103986.330	$(^3H)4d\ ^4H_{7/2}$	4804.599	−1.426		blend
				104481.590	$(^3H)4d\ ^2F_{7/2}$	4921.748	−1.081		blend
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5082.234	−0.341		blend
				105220.600	$(^3H)4d\ ^4F_{7/2}$	5107.576	−0.574		blend
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5126.016	+0.065	5126.00	lab.
				105449.540	$(^5D)5d\ ^4G_{7/2}$	5168.025	−1.175		good agreement
				105524.460	$(^3F)4d\ ^4H_{9/2}$	5188.118	−0.544	5188.12	good agreement
				105589.670	$(^3F)4d\ ^4H_{7/2}$	5205.735	−0.340		blend
				105775.491	$(^3F)4d\ ^2F_{7/2}$	5256.599	−0.442	5256.599	good agreement
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5324.675	−0.131	5234.68	good agreementy=
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5587.059	+0.466		blend
				106924.430	$(^3F)4d\ ^2G_{9/2}$	5594.582	−1.114		blend
				109901.500	$(^3G)4d\ ^2G_{7/2}$	6712.979	−1.436		
				110167.280	$(^3G)4d\ ^4F_{7/2}$	6834.961	−1.262		
				110570.300	$(^3G)4d\ ^2F_{7/2}$	7028.628	−1.389		
124783.748	$(^3F)4f$	2[4]	7/2	104023.910	$(^3H)4d\ ^4G_{5/2}$	4815.647	−0.780		not observed
				104120.270	$(^5D)5d\ ^6P_{5/2}$	4838.105	−1.439		
				104209.610	$(^3H)4d\ ^2F_{5/2}$	4859.114	−1.499		
				104569.230	$(^3P)4d\ ^4F_{5/2}$	4945.559	−1.176		weak
				105123.000	$(^3H)4d\ ^2G_{7/2}$	5084.859	−1.401		
				105291.010	$(^3F)4d\ ^4G_{7/2}$	5128.687	−0.876		blend
				105414.180	$(^3F)4d\ ^4G_{5/2}$	5161.300	+0.512	5161.3	lab, computed too strong
				105589.670	$(^3F)4d\ ^4H_{7/2}$	5208.490	−0.196	5208.501	
				105630.750	$(^5D)5d\ ^4G_{5/2}$	5219.661	−0.923		blend
				106018.640	$(^3F)4d\ ^2H_{9/2}$	5327.557	−1.482		
				106208.560	$(^3F)4d\ ^2F_{5/2}$	5382.029	−0.281	5382.12	
				106900.370	$(^3F)4d\ ^2G_{7/2}$	5590.233	−0.326	5590.22	
				107407.800	$(^3F)4d\ ^2D_{5/2}$	5753.486	−0.930		at the level of the noise
				110611.800	$(^3G)4d\ ^2F_{5/2}$	7054.248	−1.377		at the level of the noise

Table 9. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3G)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
127507.241	$(^3G)4f$	5[8]	17/2	103878.370	$(^3H)4d\ ^4I_{15/2}$	4230.919	−1.017	4230.93	
				108337.860	$(^3G)4d\ ^4I_{15/2}$	5215.200	+1.119	5215.21	
127524.122	$(^3G)4f$	5[8]	15/2	104064.670	$(^3H)4d\ ^4I_{13/2}$	4261.475	−1.477		
				104622.300	$(^3H)4d\ ^2I_{13/2}$	4365.238	−1.210		
				108133.440	$(^3G)4d\ ^4H_{13/2}$	5155.680	−0.971		
				108463.910	$(^3G)4d\ ^4I_{13/2}$	5245.071	+0.889	5245.073	lab, J78
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5296.420	−0.047	5296.418	
				109049.600	$(^3G)4d\ ^2I_{13/2}$	5411.356	+0.449		blend
127484.653	$(^3G)4f$	5[7]	15/2	108133.440	$(^3G)4d\ ^4H_{13/2}$	5166.196	+0.934	5166.2	lab
				108337.860	$(^3G)4d\ ^4I_{15/2}$	5221.353	+0.453	5221.335	lab
				108463.910	$(^3G)4d\ ^4I_{13/2}$	5255.955	−0.980		
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5307.518	−0.940		
				109049.600	$(^3G)4d\ ^2I_{13/2}$	5422.941	−1.415		
127515.235	$(^3G)4f$	5[7]	13/2	105763.270	$(^3F)4d\ ^2H_{11/2}$	4595.998	−1.059		
				106045.690	$(^3H)4d\ ^2H_{11/2}$	4656.457	−0.284		
				108133.440	$(^3G)4d\ ^4H_{13/2}$	5158.044	−0.684		
				108181.550	$(^3G)4d\ ^4G_{11/2}$	5170.879	−0.639		
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5226.670	+0.474	5226.686	lab
				108463.910	$(^3G)4d\ ^4I_{13/2}$	5247.518	+0.157	5247.536	lab
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5298.915	−1.299		
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5334.651	−0.859		
				109049.600	$(^3G)4d\ ^2I_{13/2}$	5413.960	−0.246		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	5606.354	+0.514	5606.38	
127489.429	$(^3G)4f$	5[6]	13/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	4184.848	−1.133		
				106045.690	$(^3H)4d\ ^2H_{11/2}$	4662.061	−1.312		
				108133.440	$(^3G)4d\ ^4H_{13/2}$	5164.921	+0.601	5164.9	lab
				108181.550	$(^3G)4d\ ^4G_{11/2}$	5177.791	+0.705	5177.77	lab
				108337.860	$(^3G)4d\ ^4I_{15/2}$	5220.051	−0.463		
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5233.732	−1.225		
				108463.910	$(^3G)4d\ ^4I_{13/2}$	5254.636	−0.596		
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5306.173	−0.818		
				109683.280	$(^3G)4d\ ^2H_{11/2}$	5614.479	−0.728		
127489.977	$(^3G)4f$	5[6]	11/2	103600.430	$(^3H)4d\ ^4G_{11/2}$	4184.752	−1.422		
				103683.070	$(^5D)5d\ ^4F_{9/2}$	4199.279	−1.301		
				106045.690	$(^3H)4d\ ^2H_{11/2}$	4661.942	−1.108		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	4813.800	−0.314	4813.8	
				106924.430	$(^3F)4d\ ^2G_{9/2}$	4861.143	−0.513		
				108133.440	$(^3G)4d\ ^4H_{13/2}$	5164.775	−0.273	5164.77	
				108181.550	$(^3G)4d\ ^4G_{11/2}$	5177.644	+0.437	5177.64	lab
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5233.581	−0.349	5233.58	
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5234.562	−0.887		
				109049.600	$(^3G)4d\ ^2I_{13/2}$	5421.376	−1.110		
				109625.200	$(^3G)4d\ ^2G_{9/2}$	5596.053	−0.050		computed too strong
				109683.280	$(^3G)4d\ ^2H_{11/2}$	5614.306	−0.230		
				109811.920	$(^3G)4d\ ^4F_{9/2}$	5655.161	−0.047	5655.15	
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5718.689	−0.545		
127482.748	$(^3G)4f$	5[5]	11/2	105763.270	$(^3F)4d\ ^2H_{11/2}$	4602.873	−1.478		
				106045.690	$(^3H)4d\ ^2H_{11/2}$	4663.514	−0.736		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	4815.476	−0.239		computed too strong
				108133.440	$(^3G)4d\ ^4H_{13/2}$	5166.704	−0.401		computed too strong
				108181.550	$(^3G)4d\ ^4G_{11/2}$	5179.583	+0.320		blend
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5235.563	−0.190	5235.585	blend
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5236.545	+0.191		blend, computed too strong

Table 9. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3G)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
127482.748	cont.			108463.910	$(^3G)4d\ ^4I_{13/2}$	5256.482	−0.830	5256.5	
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5308.055	−1.341		
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5343.915	−1.043		
				109625.200	$(^3G)4d\ ^2G_{9/2}$	5598.319	−0.100	5598.32	computed too weak
				109683.280	$(^3G)4d\ ^2H_{11/2}$	5616.586	−0.042	5616.6	computed too weak
				109811.920	$(^3G)4d\ ^4F_{9/2}$	5657.474	−0.662	5657.50	computed too weak
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5721.054	−0.506		
127485.362	$(^3G)4f$	5[4]	9/2	104107.950	$(^3P)4d\ ^4F_{7/2}$	4276.430	−1.168		
				104481.590	$(^3H)4d\ ^2F_{7/2}$	4345.891	−1.316		
				105775.491	$(^3F)4d\ ^2F_{7/2}$	4604.910	−1.176		
				106045.690	$(^3H)4d\ ^2H_{11/2}$	4662.945	−1.404		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	4814.870	−0.945		
				106767.210	$(^3F)4d\ ^4F_{7/2}$	4825.337	−1.318		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	4862.235	−0.425		
				108181.550	$(^3G)4d\ ^4G_{11/2}$	5178.882	−0.635		
				108365.320	$(^3G)4d\ ^4D_{7/2}$	5228.658	−0.224		blend
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5234.846	−0.695	5234.80	
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5235.828	−0.195	5235.80	blend
				108537.610	$(^3G)4d\ ^4G_{7/2}$	5276.203	−1.169		
				108577.560	$(^3G)4d\ ^4H_{9/2}$	5287.351	−1.391		
				109625.200	$(^3G)4d\ ^2G_{9/2}$	5597.499	+0.251	5597.50	computed too strong
				109683.280	$(^3G)4d\ ^2H_{11/2}$	5615.762	−0.466	5615.75	
				109811.920	$(^3G)4d\ ^4F_{9/2}$	5656.638	−0.349	5656.55	blend
				109901.500	$(^3G)4d\ ^2G_{7/2}$	5685.455	−0.333	5685.45	
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5720.199	−0.468	5720.20	
				110167.280	$(^3G)4d\ ^4F_{7/2}$	5772.711	−1.064		
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5910.253	−0.120		blend H2O
127485.699	$(^3G)4f$	5[4]	7/2	103683.070	$(^5D)5d\ ^4F_{9/2}$	4200.033	−1.226		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	4814.791	+0.017	4814.8	computed too strong
				106767.210	$(^3F)4d\ ^4F_{7/2}$	4825.259	−0.375	4825.30	blend
				106900.370	$(^3F)4d\ ^2G_{7/2}$	4856.472	−1.384		
				106924.430	$(^3F)4d\ ^2G_{9/2}$	4862.155	−0.753		
				108365.320	$(^3G)4d\ ^4D_{7/2}$	5228.566	+0.266		blend
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5235.735	−0.618		blend
				108537.610	$(^3G)4d\ ^4G_{7/2}$	5276.109	−0.999		
				109625.200	$(^3G)4d\ ^2G_{9/2}$	5597.394	−1.025		
				109811.920	$(^3G)4d\ ^4F_{9/2}$	5656.530	+0.034	5656.55	
				110065.750	$(^3G)4d\ ^2D_{5/2}$	5738.953	−1.494		
				110167.280	$(^3G)4d\ ^4F_{7/2}$	5772.598	−0.676		
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5910.135	−1.369		
127510.913	$(^3G)4f$	5[3]	5/2	106767.210	$(^3F)4d\ ^4F_{7/2}$	4819.393	−0.294	4819.40	
				106900.370	$(^3F)4d\ ^2G_{7/2}$	4850.531	−1.345		
				108365.320	$(^3G)4d\ ^4D_{7/2}$	5221.680	+0.447	5221.68	lab
				108537.610	$(^3G)4d\ ^4G_{7/2}$	5269.097	−0.794	5369.12	
				110065.750	$(^3G)4d\ ^2D_{5/2}$	5730.658	−0.761		
				110167.280	$(^3G)4d\ ^4F_{7/2}$	5764.206	−0.654		blend
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5901.339	−1.193		
127487.681	$(^3G)4f$	5[2]	3/2	106866.760	$(^3F)4d\ ^4F_{5/2}$	4848.090	−0.945		
				108642.410	$(^3G)4d\ ^4D_{5/2}$	5304.895	−0.425	5304.89	blend
				110065.750	$(^3G)4d\ ^2D_{5/2}$	5738.300	−0.104	5738.30	

Table 9. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3G)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$log\, gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
127892.981	$(^3G)4f$	4[7]	15/2	104064.670	$(^3H)4d\ ^4I_{13/2}$	4195.506	−1.455		
				104622.300	$(^3H)4d\ ^2I_{13/2}$	4296.044	−1.387		
				108133.440	$(^3G)4d\ ^4H_{13/2}$	5059.436	−0.484	5059.42	lab
				108463.910	$(^3G)4d\ ^4I_{13/2}$	5145.493	−0.007	5145.5	
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5194.901	+0.482		blend
				109049.600	$(^3G)4d\ ^2I_{13/2}$	5305.427	+0.862	5305.42	lab
127895.260	$(^3G)4f$	4[7]	13/2	104174.270	$(^3H)4d\ ^4I_{11/2}$	4214.489	−1.351		
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5124.848	−0.679		blend
				108630.429	$(^1I)5s\ e^2I_{11/2}$	5189.361	−0.144	5189.371	lab
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5194.286	−1.434		
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5228.621	+0.896	5228.635	lab
				109389.880	$(^3G)4d\ ^2I_{11/2}$	5402.332	+0.099	5402.32	lab
127875.000	$(^3G)4f$	4[6]	13/2	106045.690	$(^3H)4d\ ^2H_{11/2}$	4579.713	−0.754		
				108133.440	$(^3G)4d\ ^4H_{13/2}$	5064.044	−1.045		
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5130.176	+0.662	5130.18	lab
				108463.910	$(^3G)4d\ ^4I_{13/2}$	5150.259	−0.700		
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5199.759	−0.190		blend
				109049.600	$(^3G)4d\ 2I_{13/2}$	5310.495	+0.113	5310.5	lab
				109683.280	$(^3G)4d\ ^2H_{11/2}$	5495.480	+0.481	5495.49	lab, J78
127880.436	$(^3G)4f$	4[6]	11/2	106097.520	$(^3H)4d\ ^2H_{9/2}$	4589.468	−0.765		
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5128.745	−0.375		blend
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5129.687	−1.085		
				108577.560	$(^3G)4d\ ^4H_{9/2}$	5179.133	+0.652	5179.14	lab
				108630.429	$(^1I)5s\ e^2I_{11/2}$	5193.357	−0.797		
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5232.678	−0.047		blend
				108929.040	$(^3G)4d\ ^4I_{9/2}$	5275.188	−0.897		
				109389.880	$(^3G)4d\ ^2I_{11/2}$	5406.663	−0.491		
				109625.200	$(^3G)4d\ ^2G_{9/2}$	5476.359	−0.333	5476.38	
				109683.280	$(^3G)4d\ ^2H_{11/2}$	5493.838	−1.052		
				109811.920	$(^3G)4d\ ^4F_{9/2}$	5532.952	−0.700		
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5593.749	+0.039	5593.85	
127869.158	$(^3G)4f$	4[5]	11/2	106045.690	$(^3H)4d\ ^2H_{11/2}$	4580.939	−1.153		
				106722.170	$(^3F)4d\ ^4F_{9/2}$	4727.483	−0.893		
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5131.714	+0.220	5131.7	lab
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5132.657	+0.408		blend
				108577.560	$(^3G)4d\ ^4H_{9/2}$	5182.161	−0.938		
				108648.695	$(^1I)5s\ e^2I_{13/2}$	5201.340	−1.171		
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5235.768	−0.234		blend
				108929.040	$(^3G)4d\ ^4I_{9/2}$	5278.329	−1.413		
				109049.600	$(^3G)4d\ ^2I_{13/2}$	5312.143	−0.846		
				109625.200	$(^3G)4d\ ^2G_{9/2}$	5479.744	−0.089	5479.72	lab
				109683.280	$(^3G)4d\ ^2H_{11/2}$	5497.245	+0.050	5497.25	
				109811.920	$(^3G)4d\ ^4F_{9/2}$	5536.408	−0.555	5536.40	
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5597.281	−0.105	5597.30	
127855.952	$(^3G)4f$	4[5]	9/2	106722.170	$(^3F)4d\ ^4F_{9/2}$	4730.437	−0.906		
				106767.210	$(^3F)4d\ ^4F_{7/2}$	4740.541	−0.409		
				106900.370	$(^3F)4d\ ^2G_{7/2}$	4770.664	−1.118		
				108365.320	$(^3G)4d\ ^4D_{7/2}$	5129.241	−0.301	5129.25	
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5135.195	−0.409		blend
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5136.140	+0.294		blend
				108577.560	$(^3G)4d\ ^4H_{9/2}$	5185.710	−0.829		
				108709.450	$(^3G)4d\ ^4H_{7/2}$	5221.432	−1.407		
				109625.200	$(^3G)4d\ ^2G_{9/2}$	5483.714	+0.010	5483.70	

Table 9. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3G)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
127855.952	cont.			109683.280	$(^3G)4d\ ^2H_{11/2}$	5501.240	−0.659		
				109811.920	$(^3G)4d\ ^4F_{9/2}$	5540.460	−0.431	5540.47	
				109901.500	$(^3G)4d\ ^2G_{7/2}$	5568.103	−0.216	5568.10	
				110167.280	$(^3G)4d\ ^4F_{7/2}$	5651.767	−0.160	5651.78	computed too weak
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5783.541	−0.854		
127869.892	$(^3G)4f$	4[4]	9/2	106097.520	$(^3H)4d\ ^2H_{9/2}$	4591.690	−1.043		no soectrum
				106900.370	$(^3F)4d\ ^2G_{7/2}$	4767.493	−1.141		no spectrum
				108365.320	$(^3G)4d\ ^4D_{7/2}$	5125.575	−1.117		weak
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5132.464	−0.690		blend
				108537.610	$(^3G)4d\ ^4G_{7/2}$	5171.255	+0.332	5171.25	lab, J78
				108577.560	$(^3G)4d\ ^4H_{9/2}$	5181.963	+0.101	5181.97	lab
				108709.450	$(^3G)4d\ ^4H_{7/2}$	5217.634	−1.196		weak
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5235.567	−0.810		blend
				108929.040	$(^3G)4d\ ^4I_{9/2}$	5278.125	−0.704		blend
				109389.880	$(^3G)4d\ ^2I_{11/2}$	5409.748	−1.407		blend
				109901.500	$(^3G)4d\ ^2G_{7/2}$	5563.783	−0.269	5563.79	
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5597.051	+0.023	5597.05	
				110167.280	$(^3G)4d\ ^4F_{7/2}$	5647.317	−0.723		blend
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5778.881	−0.074	5778.88	
127874.745	$(^3G)4f$	4[3]	5/2	106767.210	$(^3F)4d\ ^4F_{7/2}$	4736.320	−0.862		no spectrum
				106796.660	$(^3F)4d\ ^4P_{5/2}$	4742.937	−1.442		no spectrum
				106866.760	$(^3F)4d\ ^4F_{5/2}$	4758.764	−0.354		no spectrum
				107407.800	$(^3F)4d\ ^2D_{5/2}$	4884.563	−1.137		blend
				108365.320	$(^3G)4d\ ^4D_{7/2}$	5124.300	−0.351	5124.3	
				108537.610	$(^3G)4d\ ^4G_{7/2}$	5169.957	−0.493	5169.95	
				108613.960	$(^3G)4d\ ^4G_{5/2}$	5190.451	−1.336		blend
				108642.410	$(^3G)4d\ ^4D_{5/2}$	5198.129	−0.577	5198.12	
				108859.470	$(^3G)4d\ ^4D_{3/2}$	5257.467	−1.074		weak
				109901.500	$(^3G)4d\ ^2G_{7/2}$	5562.281	−0.790		weak
				110065.750	$(^3G)4d\ ^2D_{5/2}$	5613.582	−0.302	5613.55	blend
				110167.280	$(^3G)4d\ ^4F_{7/2}$	5645.769	−0.897		weak
				110428.280	$(^3G)4d\ ^4F_{5/2}$	5730.231	−0.236		blend
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5777.260	−0.288	5777.73	computed too weak
				110611.800	$(^3G)4d\ ^2F_{5/2}$	5791.149	−1.493		blend
128110.214	$(^3G)4f$	3[6]	13/2	104765.450	$(^3H)4d\ ^2I_{11/2}$	4282.411	−1.266		blend
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5068.991	−0.821	5068.99	
				108630.429	$(^1I)5s\ e^2I_{11/2}$	5132.097	−0.929		blend
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5170.492	+0.154	5170.5	lab
				109389.880	$(^3G)4d\ ^2I_{11/2}$	5340.300	+0.922	5340.30	lab, J78
128071.171	$(^3F)4f$	3[5]	11/2	106097.520	$(^3H)4d\ ^2H_{9/2}$	4549.630	−0.731		no spectrum
				106924.430	$(^3F)4d\ ^2G_{9/2}$	4727.539	−0.926		no spectrum
				108387.920	$(^3G)4d\ ^4H_{11/2}$	5079.046	−1.376		blend
				108391.500	$(^3G)4d\ ^4G_{9/2}$	5079.970	−1.401		at the continuum level
				108577.560	$(^3G)4d\ ^4H_{9/2}$	5128.457	+0.377	5128.47	lab
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5180.954	−0.687		blend
				108929.040	$(^3G)4d\ ^4I_{9/2}$	5222.625	−0.245	5222.62	computed too strong
				109389.880	$(^3G)4d\ ^2I_{11/2}$	5351.461	+0.043	5351.47	
				106925.200	$(^3G)4d\ ^2G_{9/2}$	5419.731	−0.013	5419.73	lab
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5534.681	+0.459	5534.68	

Table 9. Fe II lines in the 3800-8000 Å region with log $gf \geq -1.5$ and $3d^6(^3G)4f$ energy levels as upper levels.

Upper level				Lower level		λ(calc)	$\log gf$	λ(obs)	Notes
cm^{-1}			J	cm^{-1}		Å	KUR	Å	
128055.658	$(^3F)4f$	3[5]	9/2	106097.520	$(^3H)4d\ ^2H_{9/2}$	4552.844	−1.204		no spectrum
				106767.210	$(^3F)4d\ ^4F_{7/2}$	4696.069	−0.812		no spectrum
				106924.430	$(^3F)4d\ ^2G_{9/2}$	4731.009	−1.380		no spectrum
				108537.610	$(^3G)4d\ ^4G_{7/2}$	5122.036	+0.148	5122.02	lab
				108577.560	$(^3G)4d\ ^4H_{9/2}$	5132.541	+0.038	5132.55	lab
				108709.450	$(^3G)4d\ ^4H_{7/2}$	5167.532	−0.521		blend
				108775.080	$(^3G)4d\ ^4I_{11/2}$	5185.122	−1.448	5185.141	blend
				109389.880	$(^3G)4d\ ^2I_{11/2}$	5355.908	−0.925	5355.9	weak
				106925.200	$(^3G)4d\ ^2G_{9/2}$	5424.293	−0.649		blend
				109901.500	$(^3G)4d\ ^2G_{7/2}$	5506.850	+0.159	5506.85	
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5539.439	+0.045	5539.41	
				110167.280	$(^3G)4d\ ^4F_{7/2}$	5588.670	−0.697	5588.65	
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5717.485	−0.176	5717.50	
128062.710	$(^3F)4f$	3[4]	9/2	106900.370	$(^3F)4d\ ^2G_{7/2}$	4724.054	−1.276		no spectrum
				108709.450	$(^3G)4d\ ^4H_{7/2}$	5165.649	+0.734	5165.65	lab
				108929.040	$(^3G)4d\ ^4I_{9/2}$	5224.934	+0.139	5224.938	
				109901.500	$(^3G)4d\ ^2G_{7/2}$	5504.712	−0.840		not observed
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5537.275	−1.268		at the level of the noise
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5715.180	−1.173		at the level of the noise
128066.823	$(^3F)4f$	3[4]	7/2	104023.910	$(^3H)4d\ ^4G_{5/2}$	4158.057	−1.351		not observed, wrong
				106208.560	$(^3F)4d\ ^2F_{5/2}$	4573.647	−1.130		no spectrum
				106767.210	$(^3F)4d\ ^4F_{7/2}$	4693.607	−1.067		no spectrum
				106900.370	$(^3F)4d\ ^2G_{7/2}$	4723.136	−1.319		no spectrum
				108537.610	$(^3G)4d\ ^4G_{7/2}$	5119.108	−0.444		computed too strong
				108577.560	$(^3G)4d\ ^4H_{9/2}$	5129.601	−1.316		blend
				108613.960	$(^3G)4d\ ^4G_{5/2}$	5139.200	+0.196	5139.20	lab
				108709.450	$(^3G)4d\ ^4H_{7/2}$	5164.552	−0.146	5164.52	computed too weak
				108929.040	$(^3G)4d\ ^4I_{9/2}$	5223.811	−0.993		blend
				109901.500	$(^3G)4d\ ^2G_{7/2}$	5503.465	−0.078		blend
				110008.300	$(^3G)4d\ ^2H_{9/2}$	5536.014	−0.751	5536.0	
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5713.836	−0.308	5713.8	
				110611.800	$(^3G)4d\ ^2F_{5/2}$	5727.421	−0.043	5727.45	
128063.103	$(^3G)4f$	3[3]	5/2	106864.650	$(^3G)4d\ ^4F_{3/2}$	4712.005	−0.481		no spectrum
				106866.760	$(^3F)4d\ ^4F_{5/2}$	4716.475	−1.431		no spectrum
				107430.250	$(^3F)4d\ ^2D_{3/2}$	4845.286	−0.946		blend,computed too strong
				108613.960	$(^3G)4d\ ^4G_{5/2}$	5140.183	+0.037	5140.19	
				108642.410	$(^3G)4d\ ^4D_{5/2}$	5147.713	−0.412	5147.71	computed too weak
				108709.450	$(^3G)4d\ ^4H_{7/2}$	5165.544	−0.693		blend
				108859.470	$(^3G)4d\ ^4D_{3/2}$	5205.898	−0.225	5205.879	
				109901.500	$(^3G)4d\ ^2G_{5/2}$	5504.593	−1.414		at the continuum level
				110428.280	$(^3G)4d\ ^4F_{5/2}$	5669.025	−0.651	5669.03	
				110461.260	$(^3G)4d\ ^2D_{3/2}$	5679.647	−1.133		at the level of the noise
				110609.540	$(^3G)4d\ ^4F_{3/2}$	5727.900	−0.186	5727.90	
				110611.800	$(^3G)4d\ ^2F_{5/2}$	5728.642	−0.772		weak
128089.313	$(^3G)4f$	3[2]	5/2	106208.560	$(^3F)4d\ ^2F_{5/2}$	4568.946	−1.396		no spectrum
				106747.210	$(^5D)5d\ ^4F_{7/2}$	4688.657	−1.457		no spectrum
				106796.660	$(^3F)4d\ ^4P_{5/2}$	4695.142	−1.393		no spectrum
				106866.760	$(^3F)4d\ ^4F_{5/2}$	4710.650	−1.102		no spectrum
				108537.610	$(^3G)4d\ ^4G_{7/2}$	5113.219	−1.022		at the continuum level
				108642.410	$(^3G)4d\ ^4D_{5/2}$	5140.775	−0.580		blend
				108859.470	$(^3G)4d\ ^4D_{3/2}$	5198.803	−0.577		blend
				109901.500	$(^3G)4d\ ^2G_{5/2}$	5496.660	−0.747		blend
				110428.280	$(^3G)4d\ ^4F_{5/2}$	5660.612	−0.985		blend
				110461.260	$(^3G)4d\ ^2D_{3/2}$	5671.202	−0.429	5671.20	
				110570.300	$(^3G)4d\ ^2F_{7/2}$	5706.501	−0.913		at the level of the noise
				110611.800	$(^3G)4d\ ^2F_{5/2}$	5720.051	+0.065	5720.05	